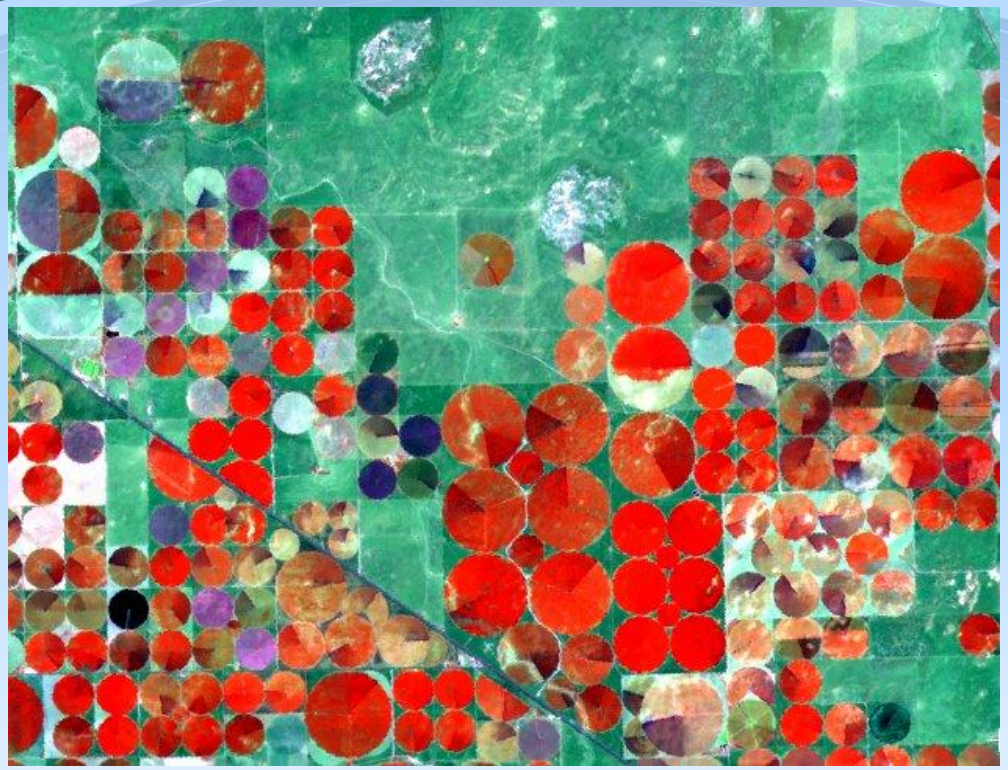
USDA Remote Sensing Overview



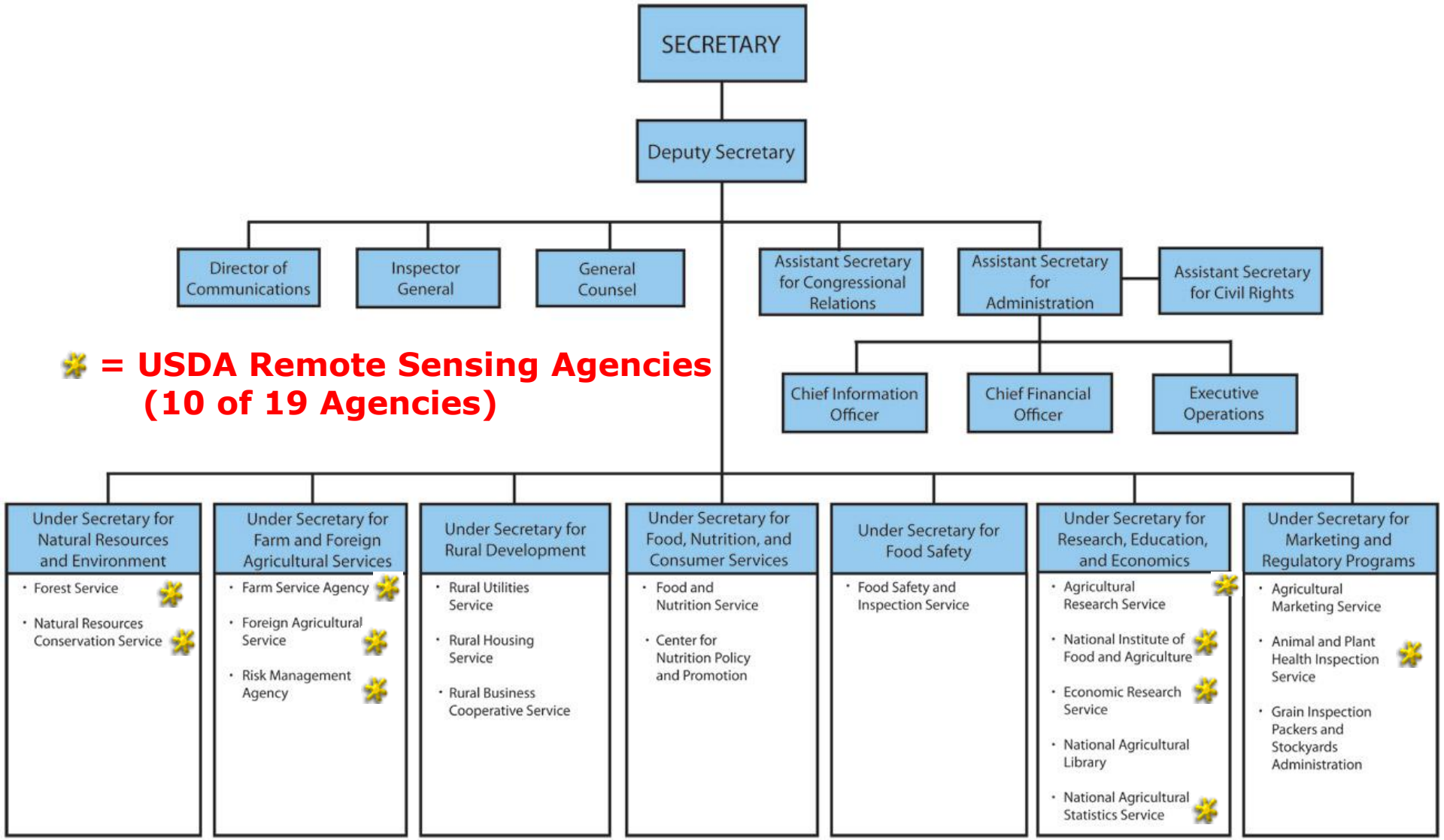
Curt Reynolds and Glenn Bethel

JACIE Workshop, Boulder, CO, March 29, 2011

curt.reynolds@fas.usda.gov

USDA

Linking U.S. Agriculture FAS to the World



= USDA Remote Sensing Agencies (10 of 19 Agencies)

USDA has over 65,000 ESRI desktop licenses

USDA's Interrelated Policy and Program Considerations

- Commodity programs
- Conservation
- Agricultural trade
- U.S. Nutrition programs
- Rural development
- Agricultural research, education, and extension
- Forest Health
- Sustainable Agriculture
- Sustainable Forestry
- Disaster programs

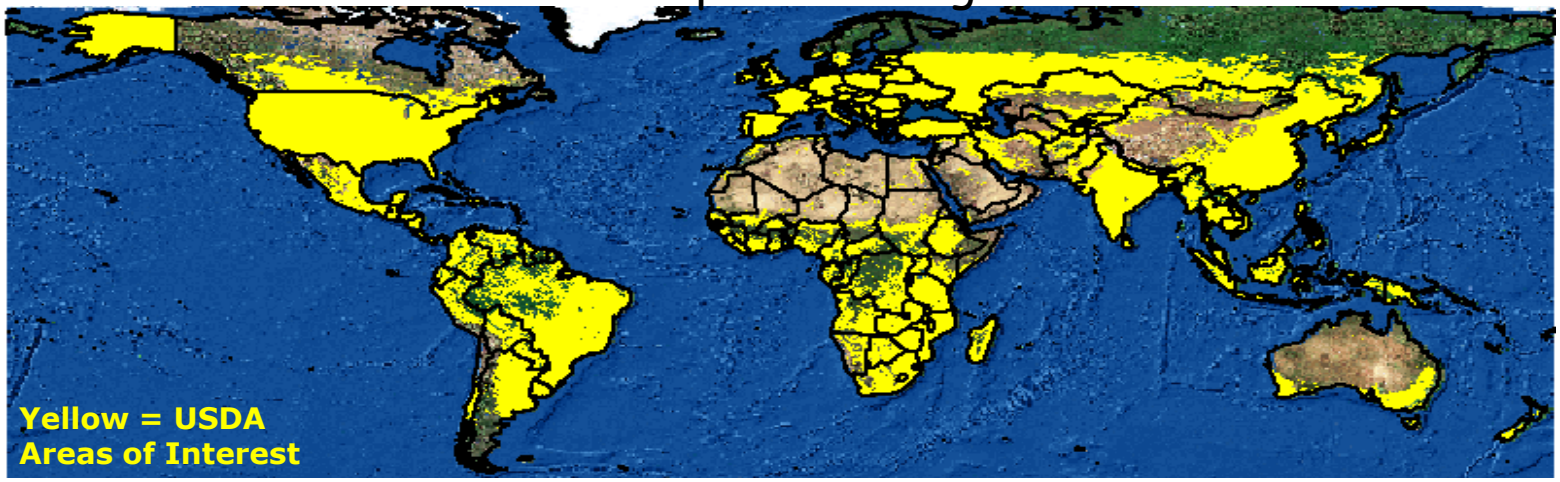
- Wildland fire
- Carbon Markets
- Environment
- Climate change
- Trade Policy
- Dealing with longer-term scarcity concerns:
  - Land availability
  - Water
  - Food production inputs, especially energy
- Energy / Biofuels

USDA

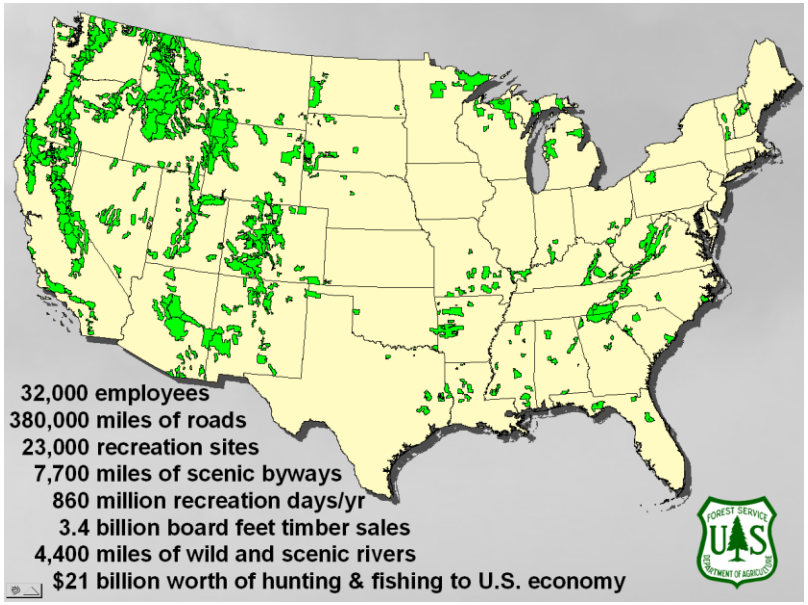
Linking U.S. Agriculture FAS to the World

Global to Field Level Requirements

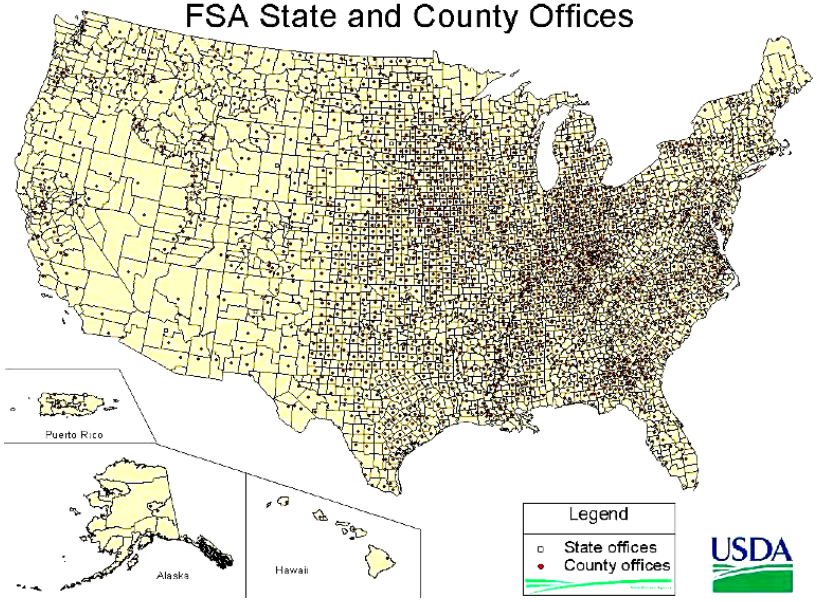
Global Crop Monitoring



Green = Forest Service Land



FSA State and County Offices



Early Cooperative Research between USDA, NASA, & NOAA

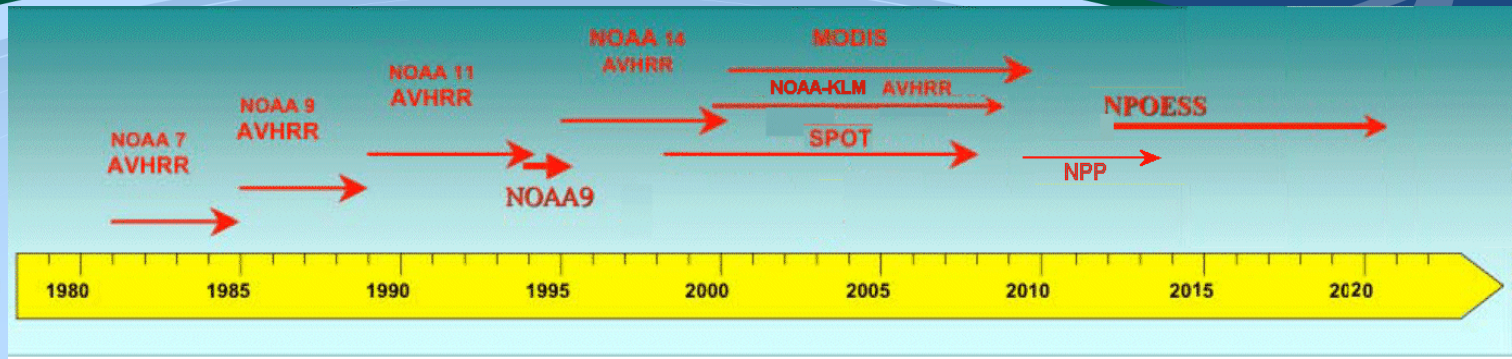
- LACIE (Large Area Crop Inventory Experiment)-1975-79
  - "Determine the practicality and utility of computer analyzed remotely sensed data in crop forecasting"
  - Launch of Landsat and Great Russian Grain Robbery in 1972 helped to motivate funding for LACIE.
- AgRISTARS (1980-85)- operational program to monitor crop production in USSR with satellites
- Principal satellites were ***Landsat*** & ***AVHRR-NOAA***

USDA

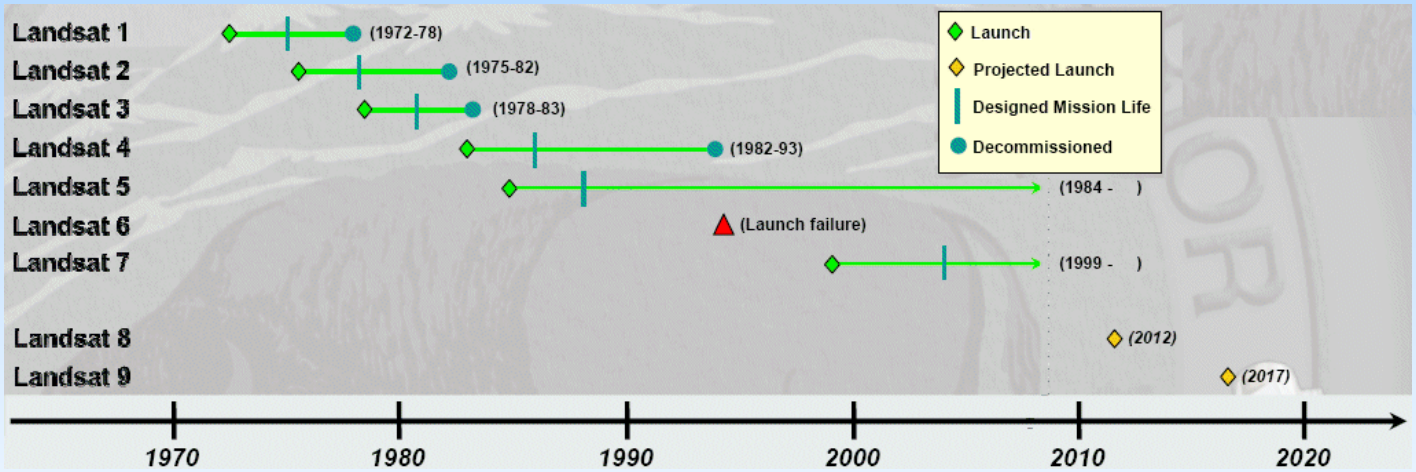
Linking U.S. Agriculture FAS to the World

Crop Monitoring Heritage

Crop Yield
(AVHRR/MODIS/VIIRS)



Crop Area
(Landsat/AWiFS)



Free Landsat imagery greatly assists USDA and is USG's gift to mankind for better understanding planet Earth

USDA

Linking U.S. Agriculture FAS to the World

Crop Monitoring and .....

- FAS/WAOB (Foreign Agricultural Service/World Agricultural Outlook Board)
  - **National crop estimates with global coverage** for monthly WASDE (World Agriculture Supply and Demand Estimates) report
- NASS (National Agriculture Statistical Service)
  - US **Crop Data Layer (CDL)** derived from Landsat/AWiFS data
- ARS (Agricultural Research Service)
  - **Remote sensing research** for agriculture applications
- FS (Forest Service)
  - **Forest mapping** and **forest fire monitoring**
- RMA (Risk Management Agency)
  - **Combat crop insurance fraud**
- APHIS (Animal and Plant Health Inspection Service)
  - **Identify invasive species**
- FSA (Farm Service Agency)
  - National Agriculture Imagery Program (NAIP)- **aerial orthoimagery**
- NRCS (Natural Resources Conservation Service)
  - **National Resources Inventory (NRI) and Wetlands Reserve Program (WRP)**

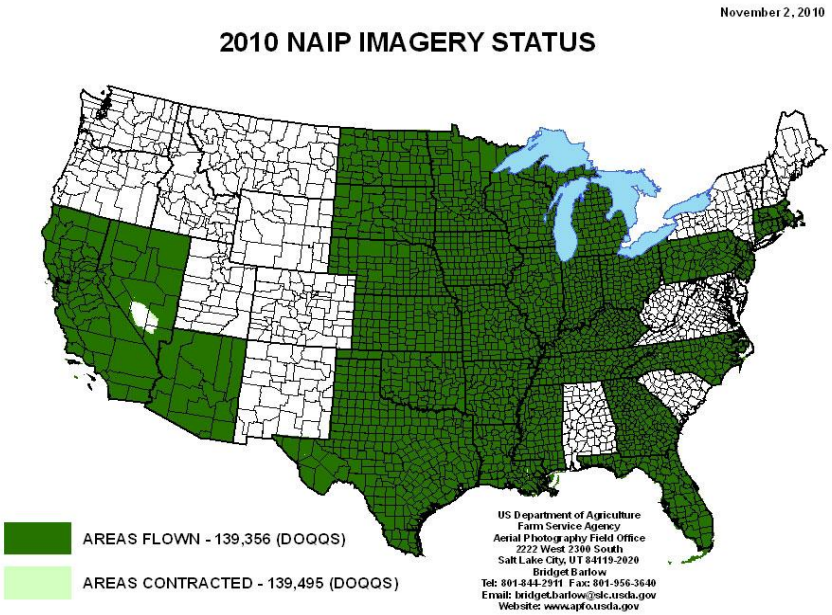
USDA

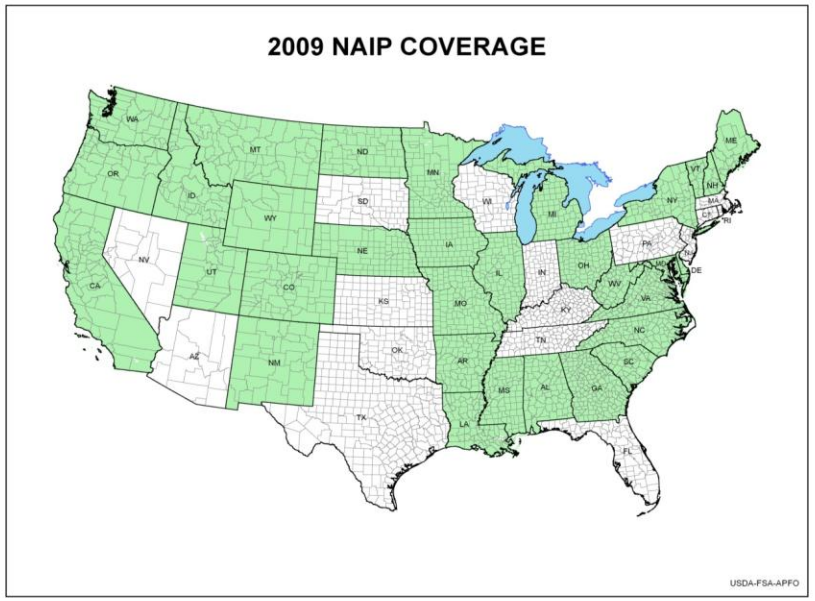
Linking U.S. Agriculture FAS to the World

USDA Remote Sensing Investments

- *Aerial and High-resolution imagery* for the US
  - National Agriculture Imagery Program (NAIP) by USDA/FSA
  - Special imagery collections for Hawaii, Alaska and US Territories (USDA/FS and USDA/NRCS)
- *Moderate-resolution imagery* (10-56-meter) for monitoring agriculture and forestry in the US
  - USDA Satellite Imagery Archive (AWiFS & SPOT4/5 with USGS)
  - USDA/NASS Crop Data Layer
- *Coarse resolution time-series imagery* (250-meter) for global crop monitoring
  - USDA and NASA Global Agriculture Monitoring (GLAM) Project
    - Global MODIS (250-meter) Time-Series for Cropland Data Drilling

National Agriculture Imagery Program (NAIP) by USDA's Farm Service Agency (FSA)



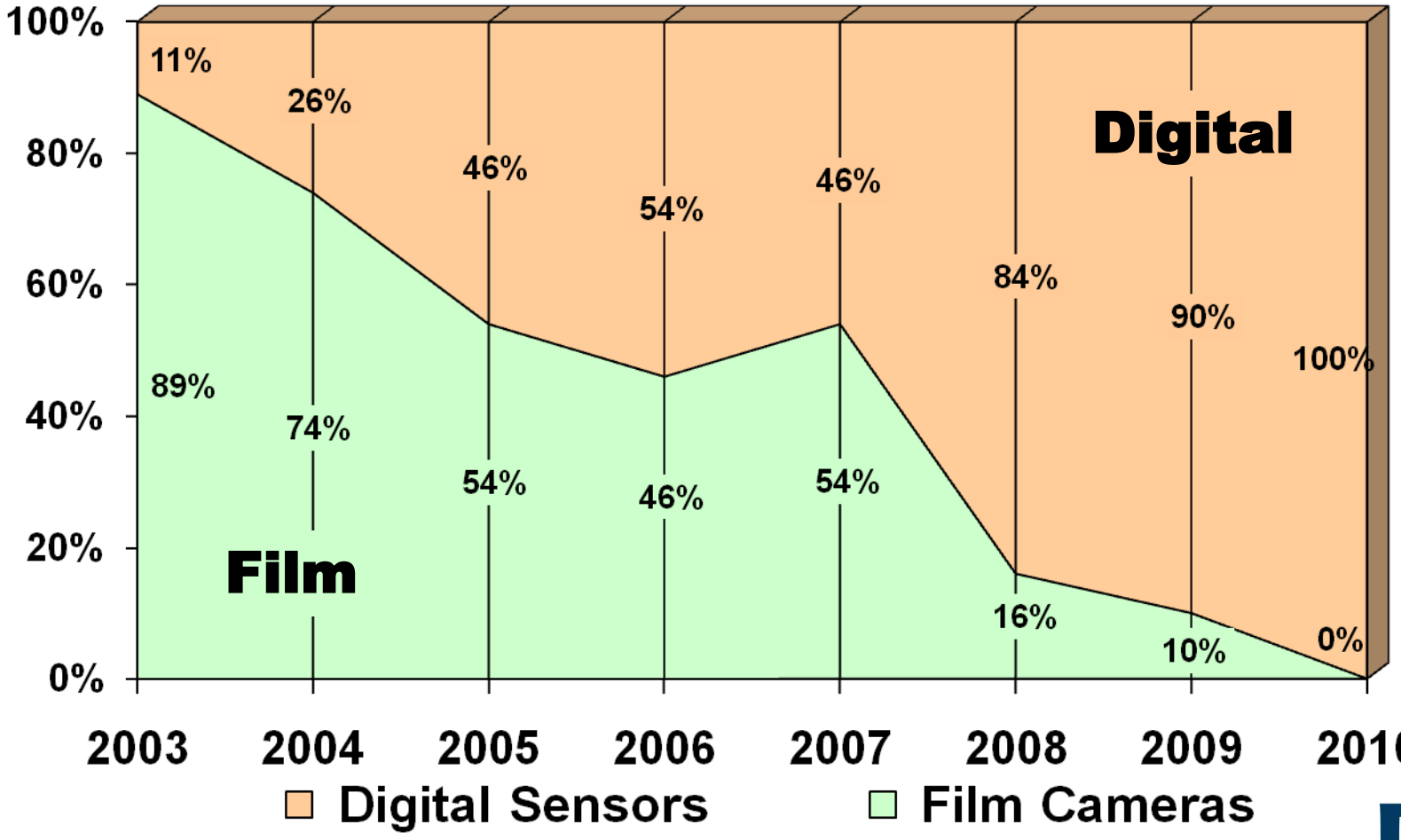


>100% Coverage in Two Years

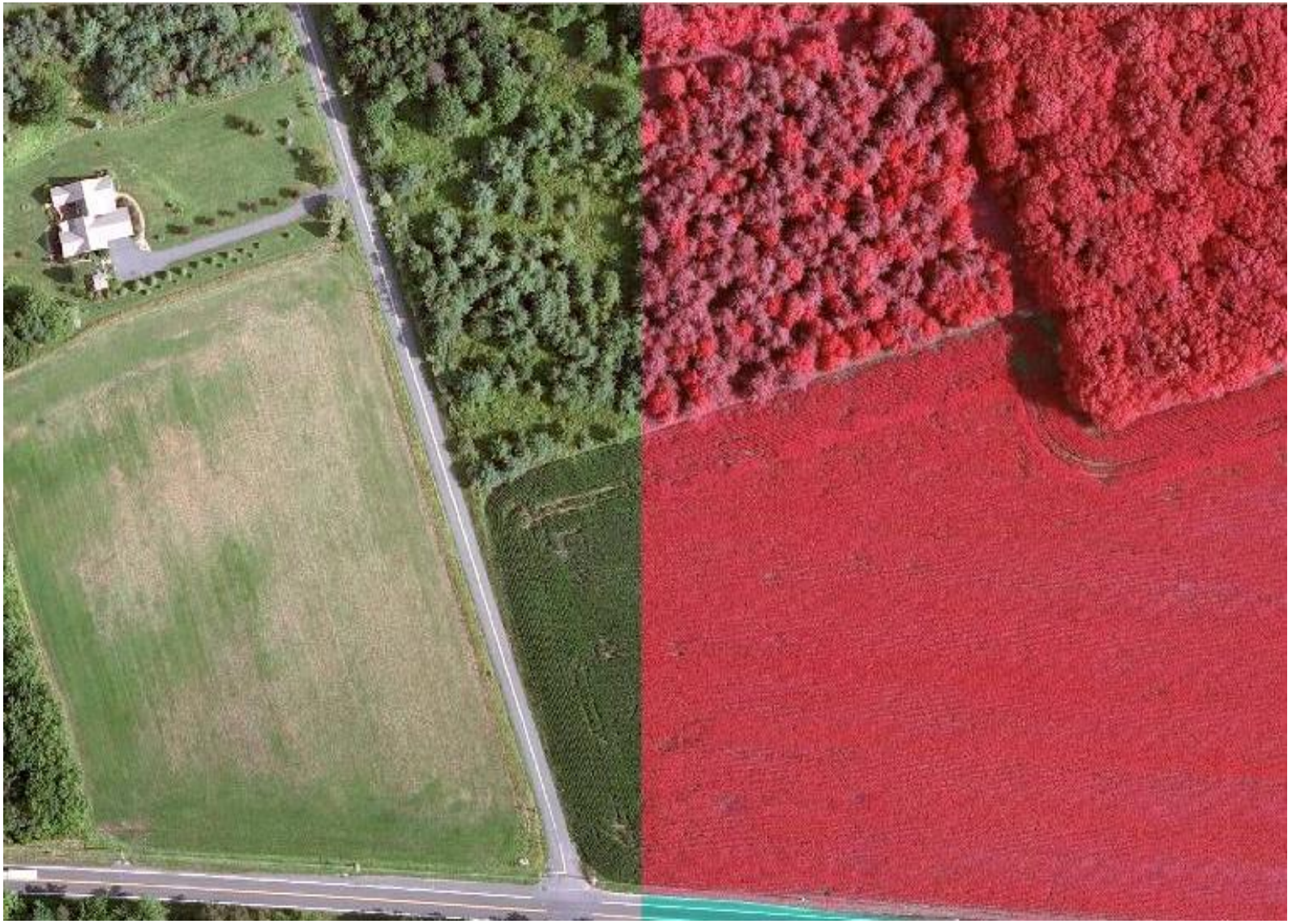
FSA
FARM SERVICE AGENCY

NAIP Camera Trends

Film Cameras vs. Digital Sensors



Four Band Imagery Increases Applications



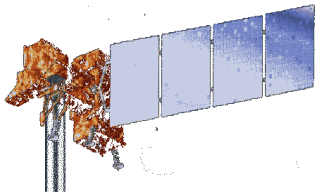
UltraCamX – Color and CIR – 8” GSD

Bethel JACIE 2011

FSA
FARM SERVICE AGENCY

USDA Satellite Acquisitions

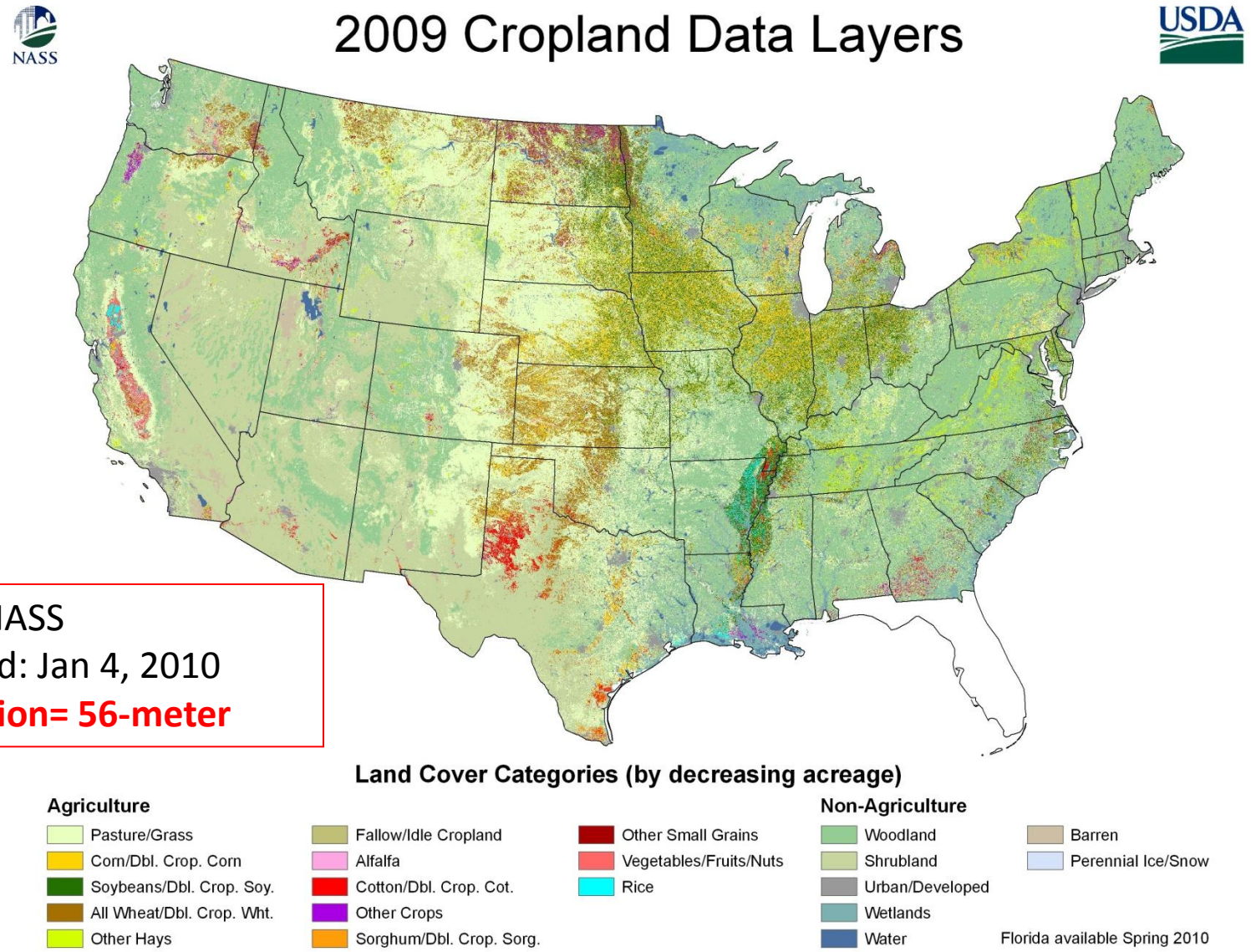




- USDA agencies ***partner*** with each other to leverage imagery investments
  - USDA's Satellite Imagery Archive (SIA) is central depository for imagery investments by ARS, NASS, FAS, FSA, RMA, FS, APHIS, and NRCS
  - AWiFS imagery from 2005-current

- USDA ***partners*** with USGS, NASA, NGIA and other agencies for imagery acquisitions and applications.
  - SPOT4/5 imagery with USGS (2010-2011)
  - USDA/NASA Global Agriculture Monitoring (GLAM)

AWiFS Imagery Allowed Coast-to-Coast Cropland Data Layer Production in 2009



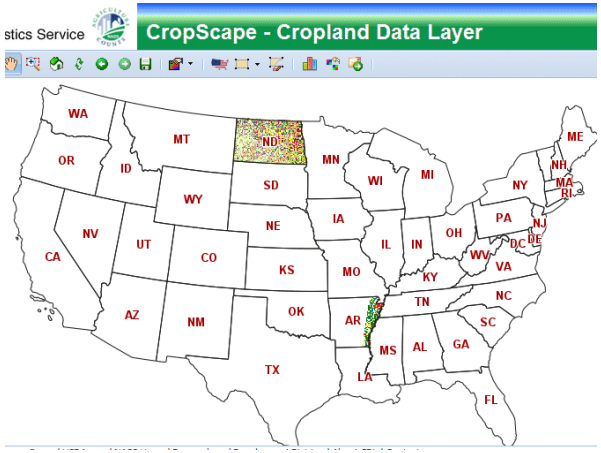
USDA/NASS
Released: Jan 4, 2010
Resolution= 56-meter

Source: http://nassgeodata.gmu.edu/CropScape

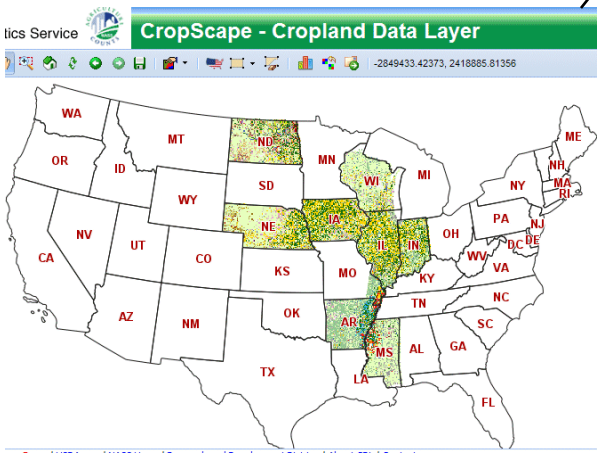
NASS

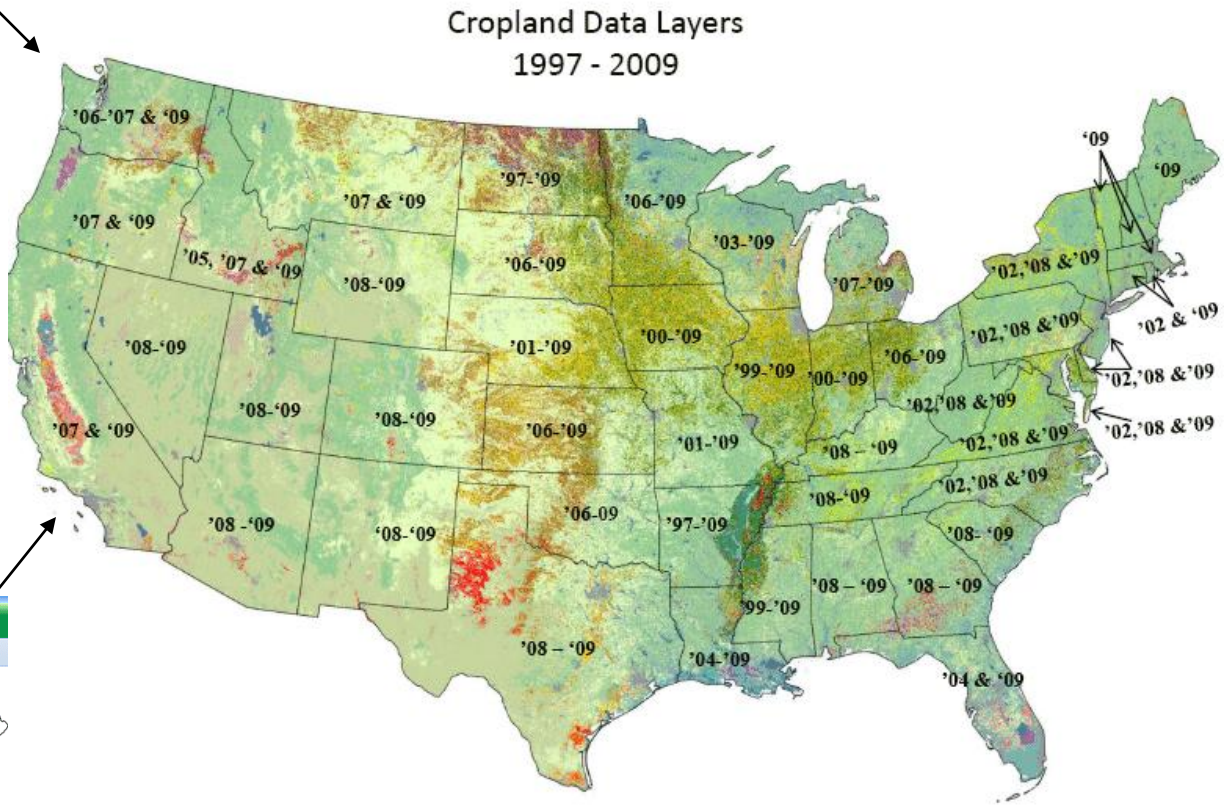
Historical NASS CDL Development

NASS 1997 CDL



NASS 2003 CDL

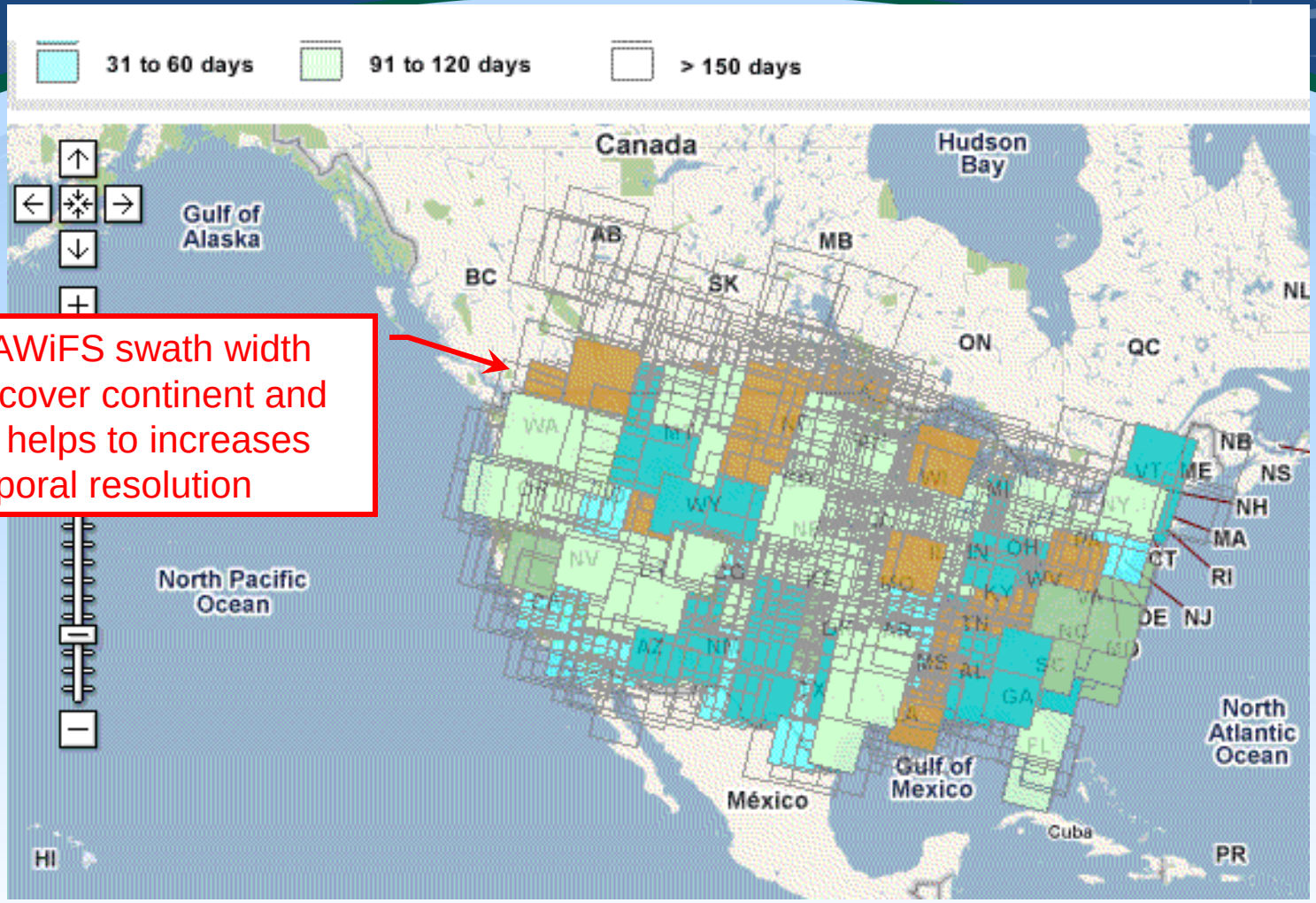




Source: http://nassgeodata.gmu.edu/CropScape

NASS

AWiFS Imagery (larger swath width & greater repeat coverage than Landsat)



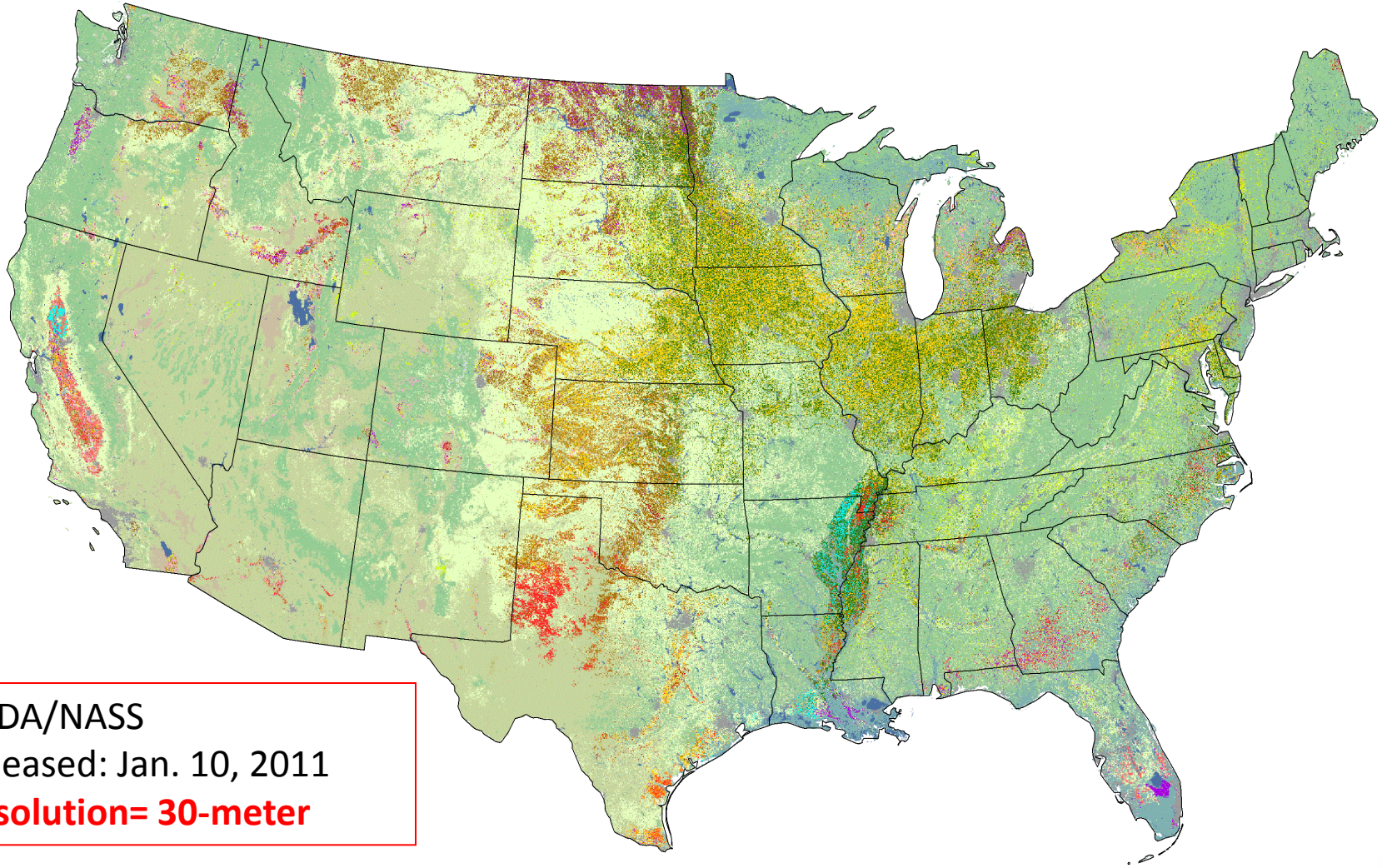
Larger AWiFS swath width helps to cover continent and overlap helps to increases temporal resolution

Source: http://www.pecad.fas.usda.gov/archive_explorer/default.cfm

USDA

Linking U.S. Agriculture FAS to the World

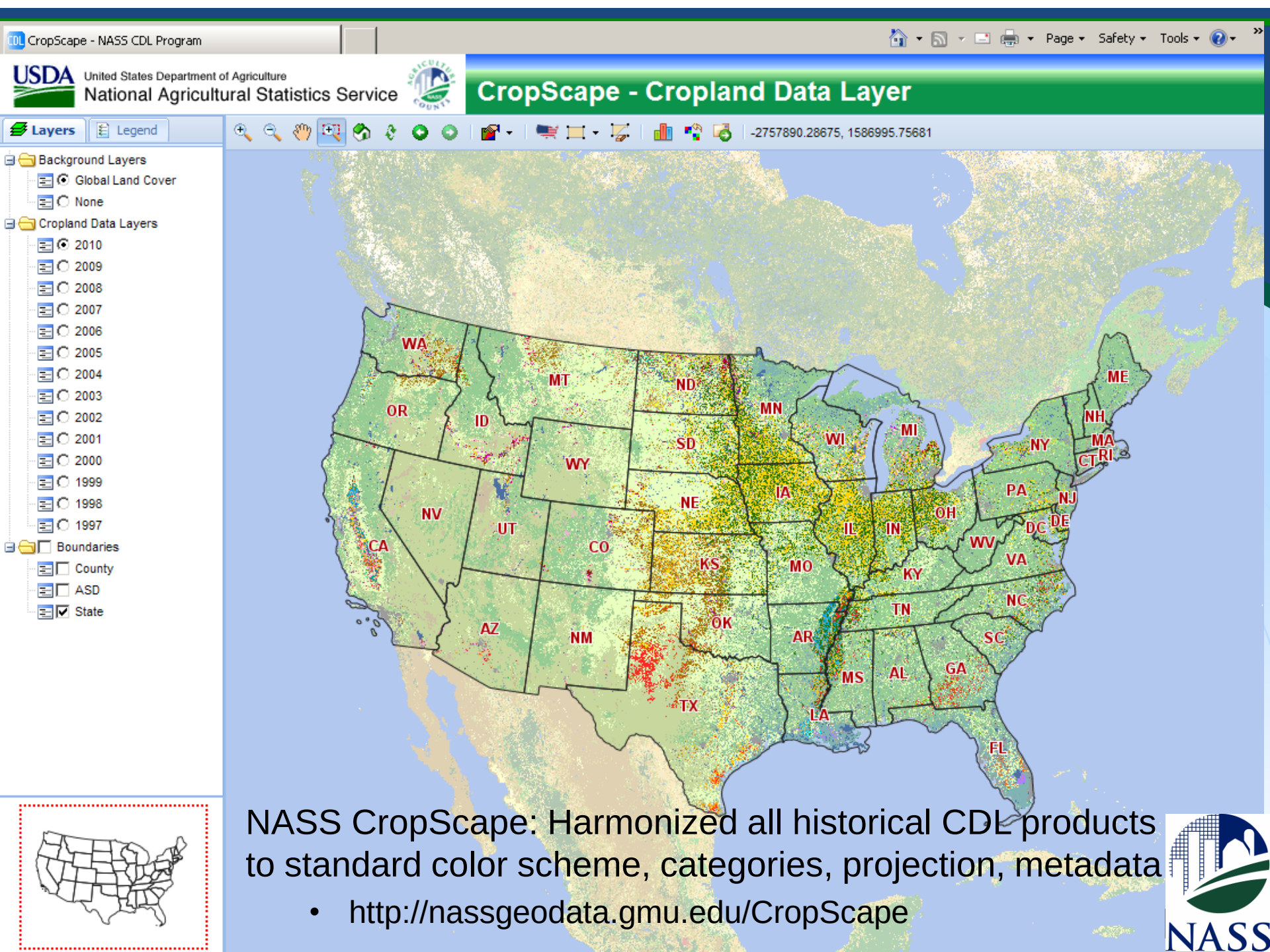
2010 Cropland Data Layers



USDA/NASS
Released: Jan. 10, 2011
Resolution= 30-meter

National product contains 55 billion pixels processed from 8,601 scenes Landsat and 1,194 AWiFS scenes.

Source: http://nassgeodata.gmu.edu/CropScape


CropScape - NASS CDL Program
Page
Safety
Tools
USDA
United States Department of Agriculture
National Agricultural Statistics Service
CropScape - Cropland Data Layer
Layers
Legend
-2757890.28675, 1586995.75681
Background Layers
Global Land Cover
None
Cropland Data Layers
2010
2009
2008
2007
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997
Boundaries
County
ASD
State
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
ME
NH
MA
CT
RI
NJ
DE
DC
NASS
NASS CropScape: Harmonized all historical CDL products to standard color scheme, categories, projection, metadata
http://nassgeodata.gmu.edu/CropScape

2010 Cropland Data Layer
McLean County, IL

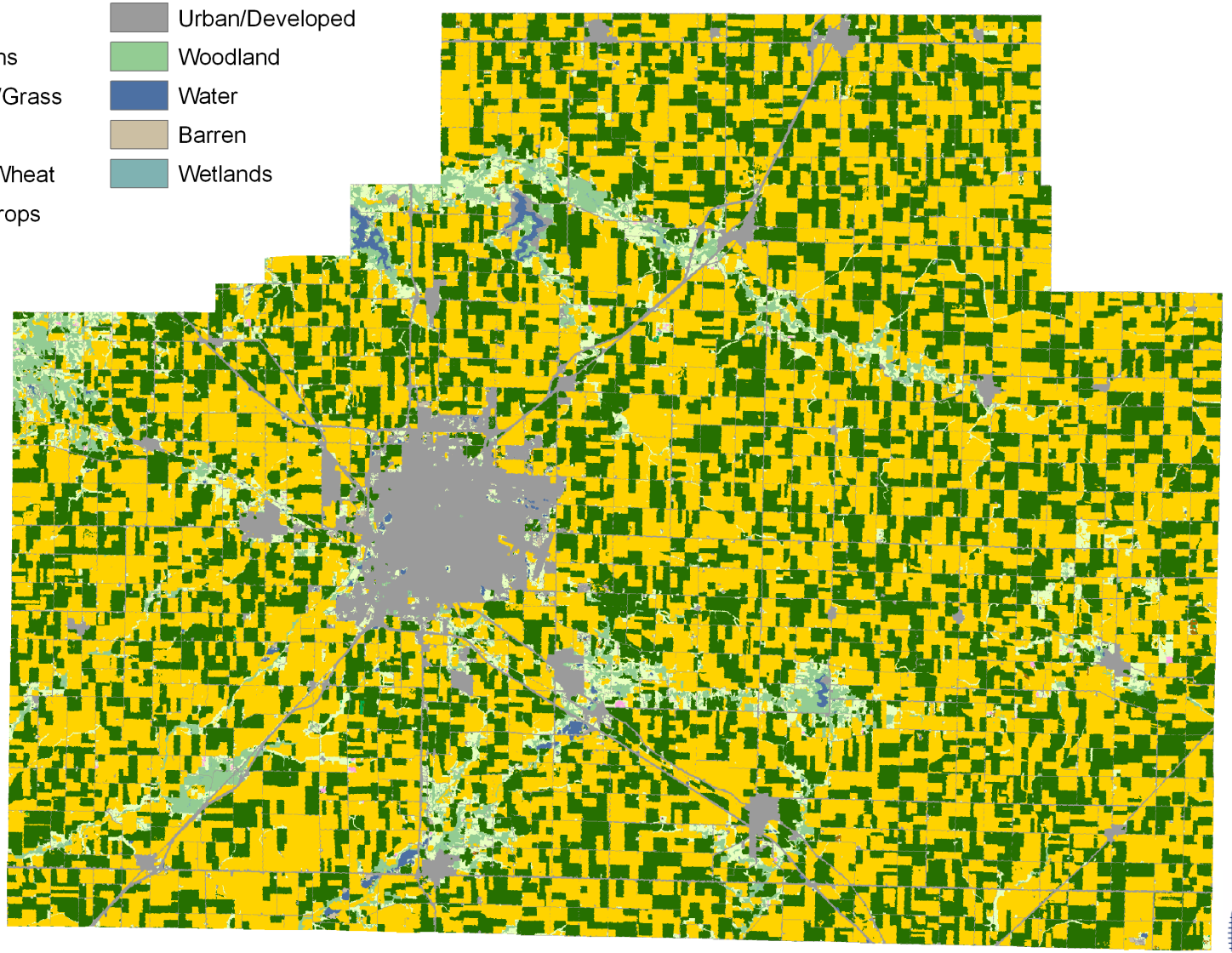
Land Cover Categories
(by decreasing acreage)

Agriculture

- Corn
- Soybeans
- Pasture/Grass
- Alfalfa
- Winter Wheat
- Other Crops

Non-Agriculture

- Urban/Developed
- Woodland
- Water
- Barren
- Wetlands

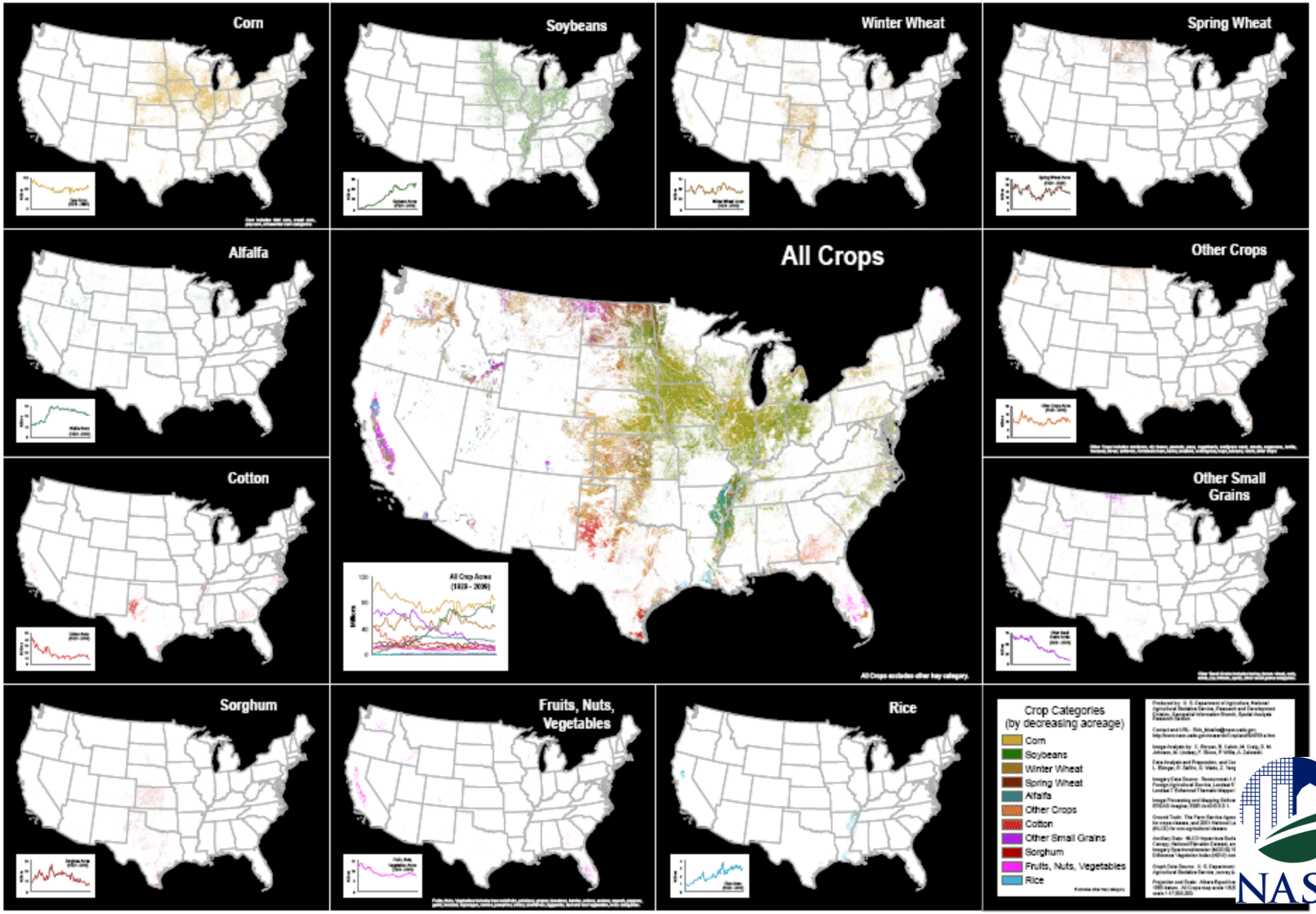


Source: http://www.nass.usda.gov/Education_and_Outreach/Reports,_Presentations_and_Conferences/Presentations/index.asp

NASS

United States Department of Agriculture, National Agricultural Statistics Service

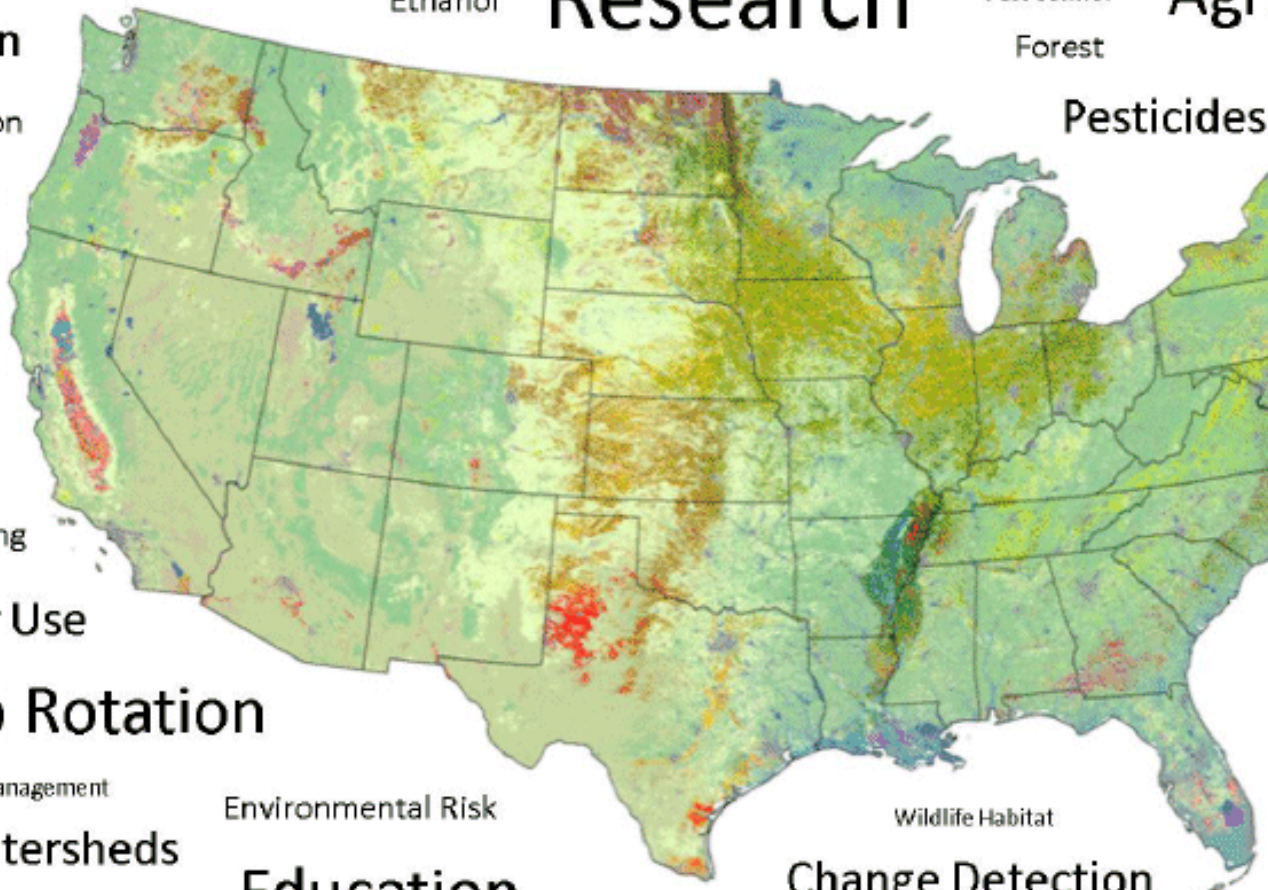
2009 Cropland Data Layer: Crop-Specific Images



NASS

Source: http://www.nass.usda.gov/Education_and_Outreach/Reports,_Presentations_and_Conferences/Presentations/index.asp

NASS Cropland Data Layer Applications

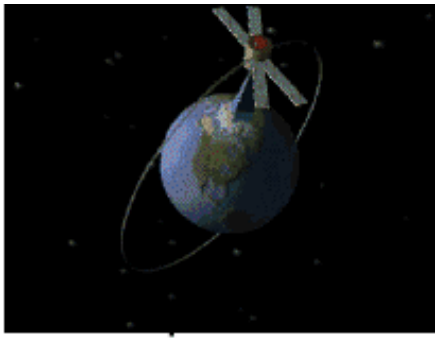


Climate
Acreage Estimates
Modeling
Irrigation
Epidemiology
Land Cover
Soil Utilization
Ethanol
Research
Pest Control
Agribusiness
Carbon
Forest
Biodiesel
Erosion
Pesticides
Ecology
Fertilizer
Yield
Biofuel
CRP
Land Use
Ecosystem
Commodity
Planning
Urban Growth
Water Use
Soil and Water
Crop Rotation
Fertilizer Usage
Crop Intensity
Land Management
Environmental Risk
Wildlife Habitat
Water Quality
Watersheds
Education
Change Detection
Mapping
Transportation
Data Mining
Condition Assessment
Disaster Assessment
Crop Production
Crop Protection

NASS

Source: http://www.nass.usda.gov/Education_and_Outreach/Reports,_Presentations_and_Conferences/Presentations/index.asp

NASS Cropland Data Layer (CDL) Partnerships



- Foreign Agricultural Service
  - Resourcesat-1 AWiFS

Linking U.S. Agriculture FAS to the World

- Farm Service Agency
  - Common Land Unit "ground truth"

USDA Farm Service Agency

- US Geological Survey
  - National Land Cover Dataset

MRLC Consortium

- US Geological Survey/ NASA
  - Landsat TM 5 & 7
  - MODIS

USGS science for a changing world

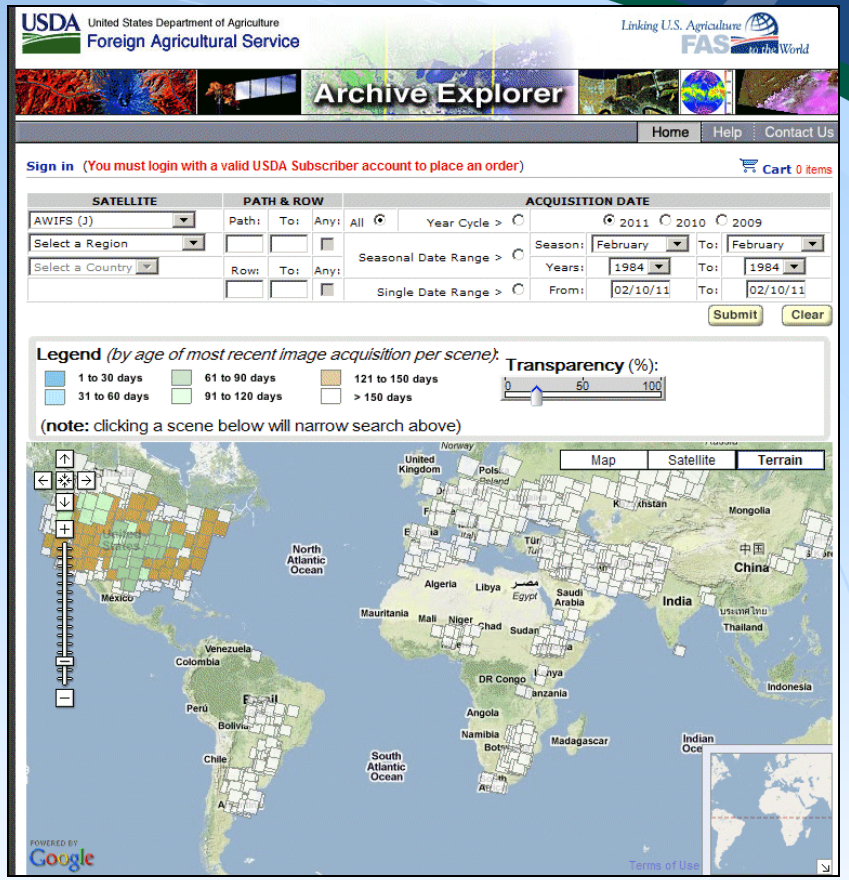
NASA

NASS

Source: http://www.nass.usda.gov/Education_and_Outreach/Reports,_Presentations_and_Conferences/Presentations/index.asp

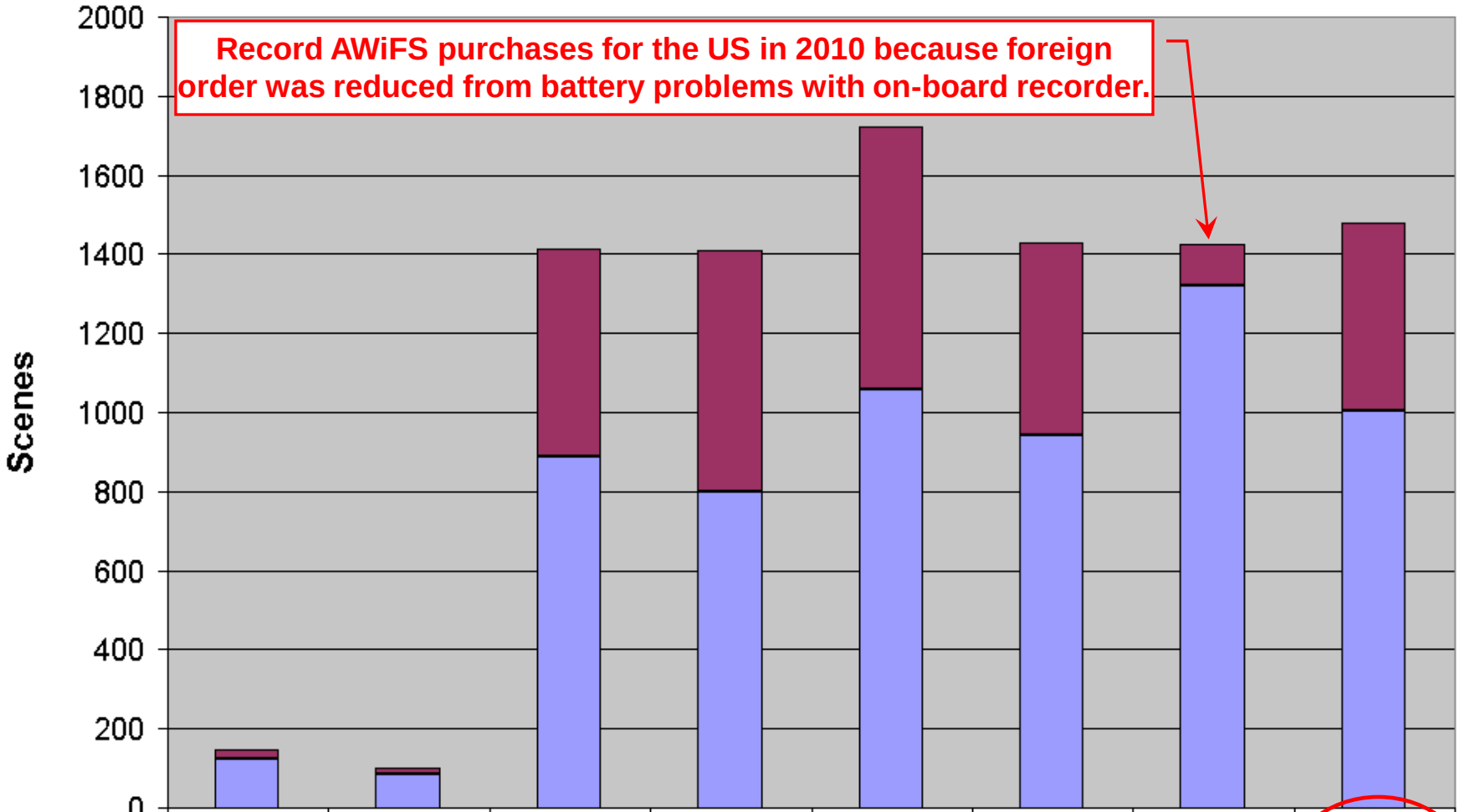
USDA's Satellite Imagery Archive (SIA) and Archive Explorer

- Archive Explorer disseminates **AWiFS Imagery** for USDA users
  - http://www.pecad.fas.usda.gov/archive_explorer/default.cfm
- Bulk imagery download via ftp
  - ftp://rasta.gdacorp.com
  - EarthWhere graphical interface at http://sia.fas.usda.gov/



Archive Explorer: http://www.pecad.fas.usda.gov/archive_explorer/default.cfm

AWiFS Scenes Purchased by USDA/SIA

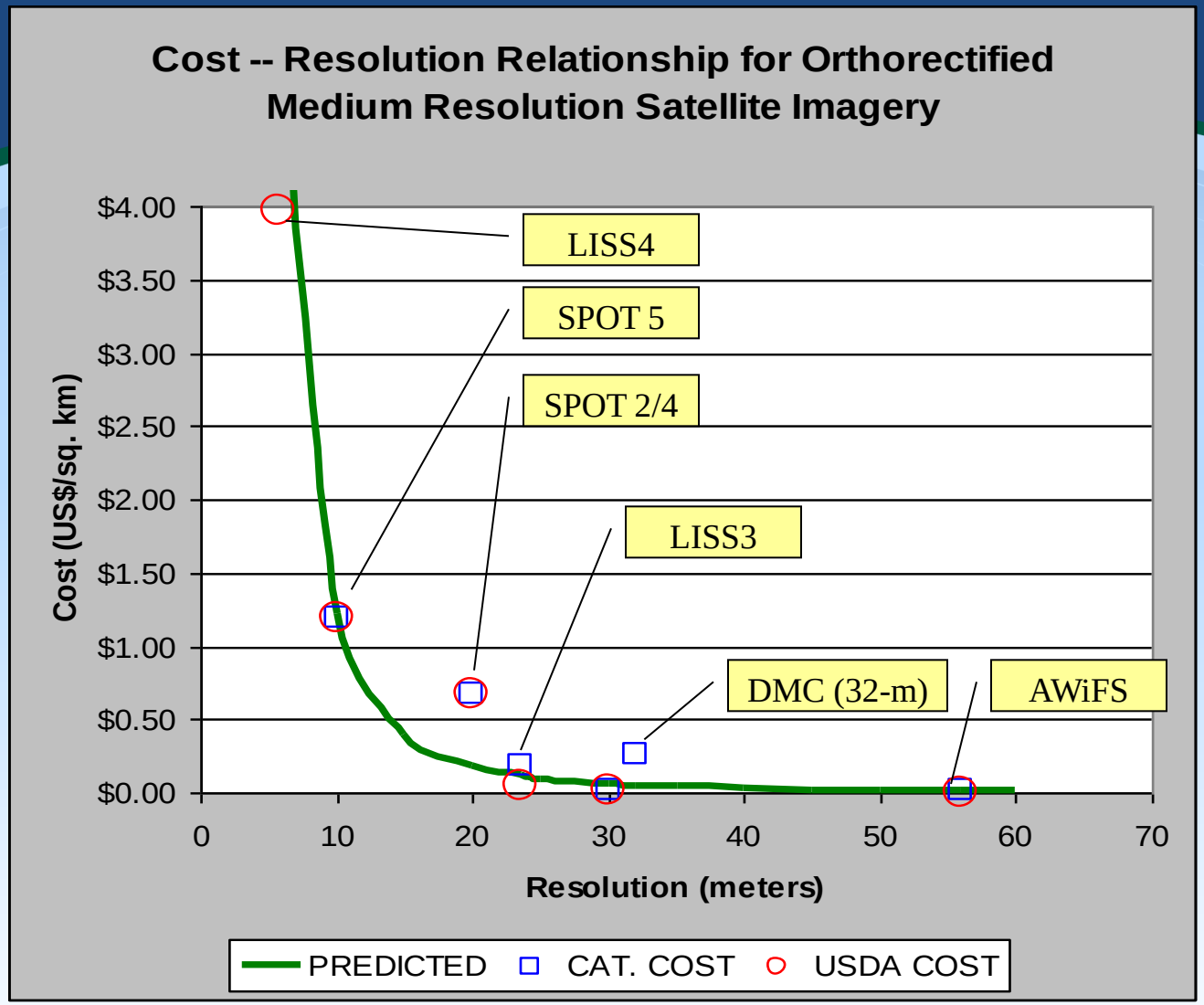


	2004	2005	2006	2007	2008	2009	2010	5-yr Avg
Foreign	21	16	527	610	664	486	102	478
US	125	84	888	798	1059	944	1322	1002

US received approximately 2/3 of total AWiFS scenes and foreign countries received 1/3 of total.

Linking U.S. Agriculture FAS to the World

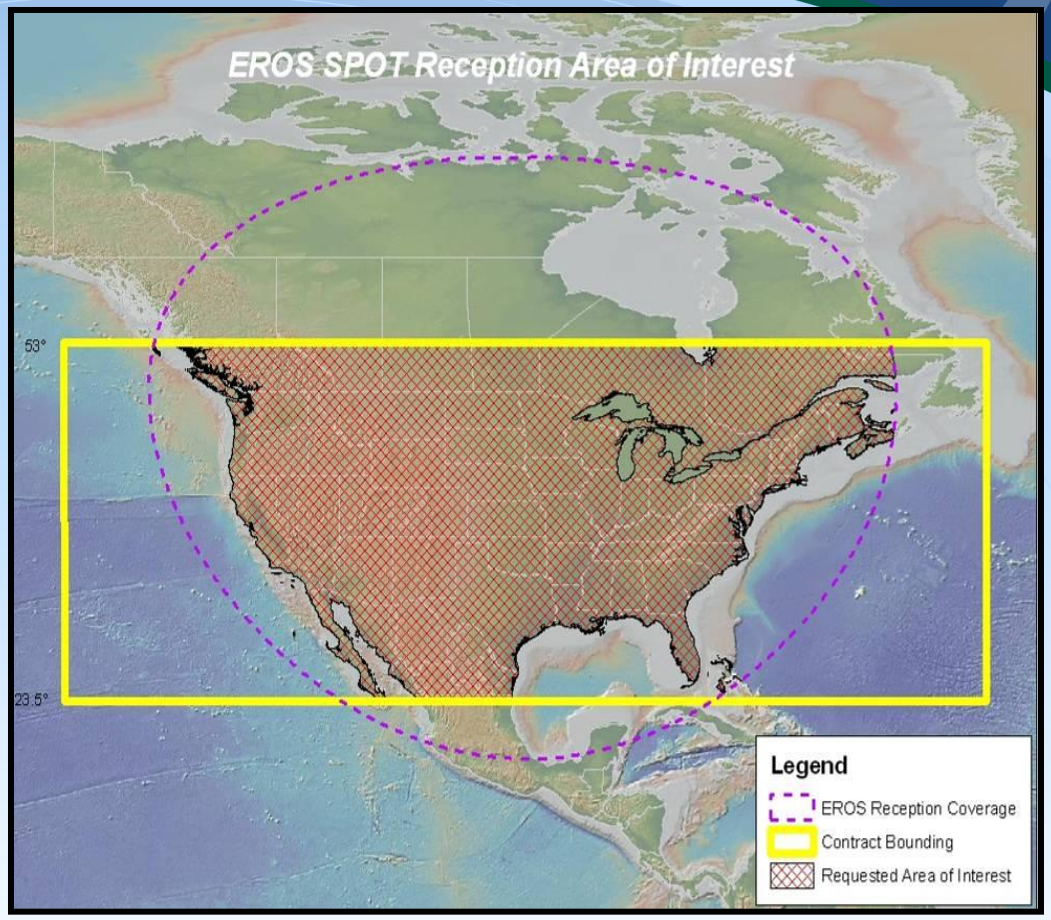
Imagery Costs vs. Spatial Resolution



Source: Unpublished draft, Joseph Godfrey,
"A Price Analysis of Multispectral, Land-Imaging Satellites", April 8, 2008

USDA Partners with USGS for 2010 and 2011 SPOT-4/5 Imagery

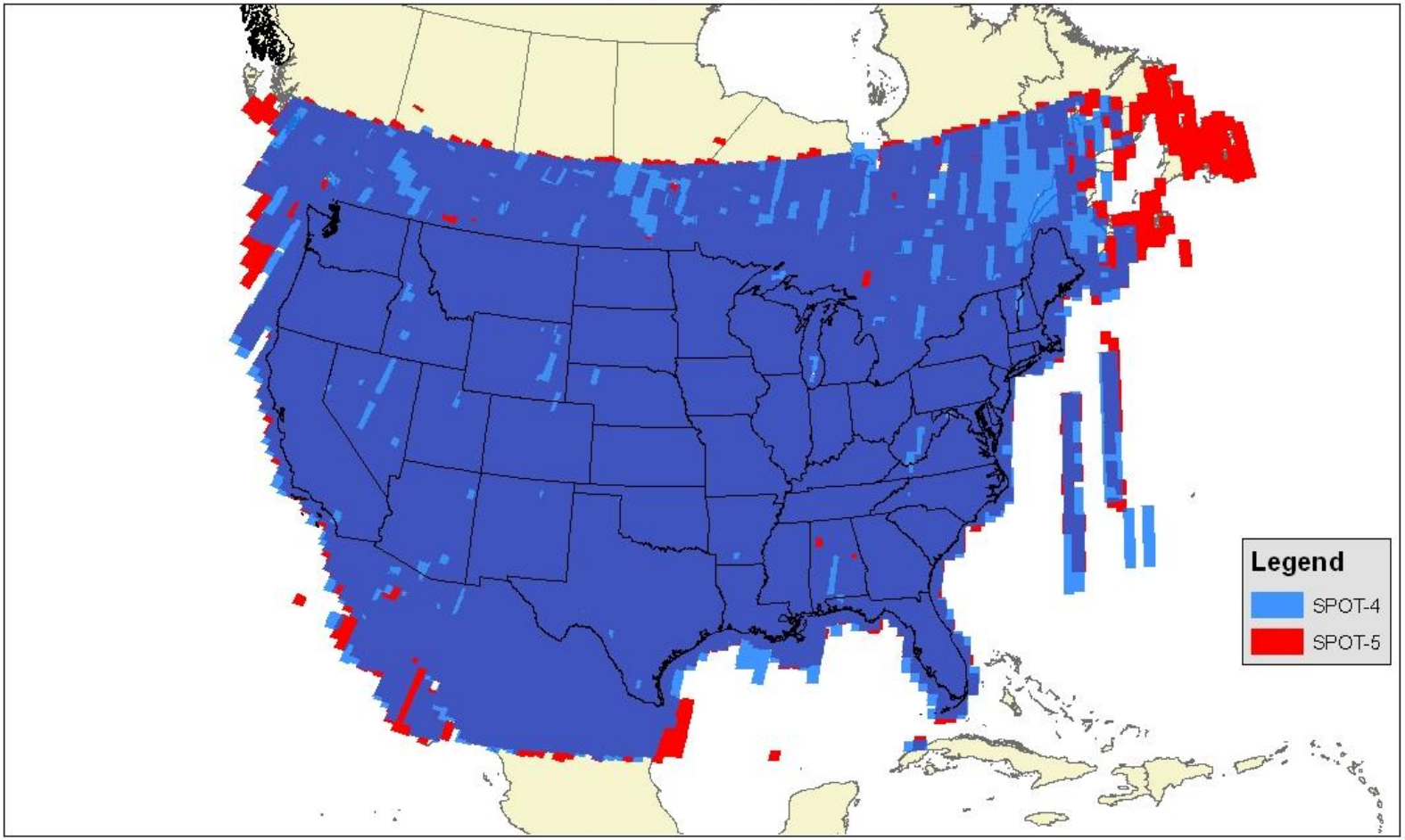
- SPOT4/5 collections cover conterminous U.S. and parts of Canada and Mexico.
- Ground receiving station at USGS-Sioux Falls



USDA

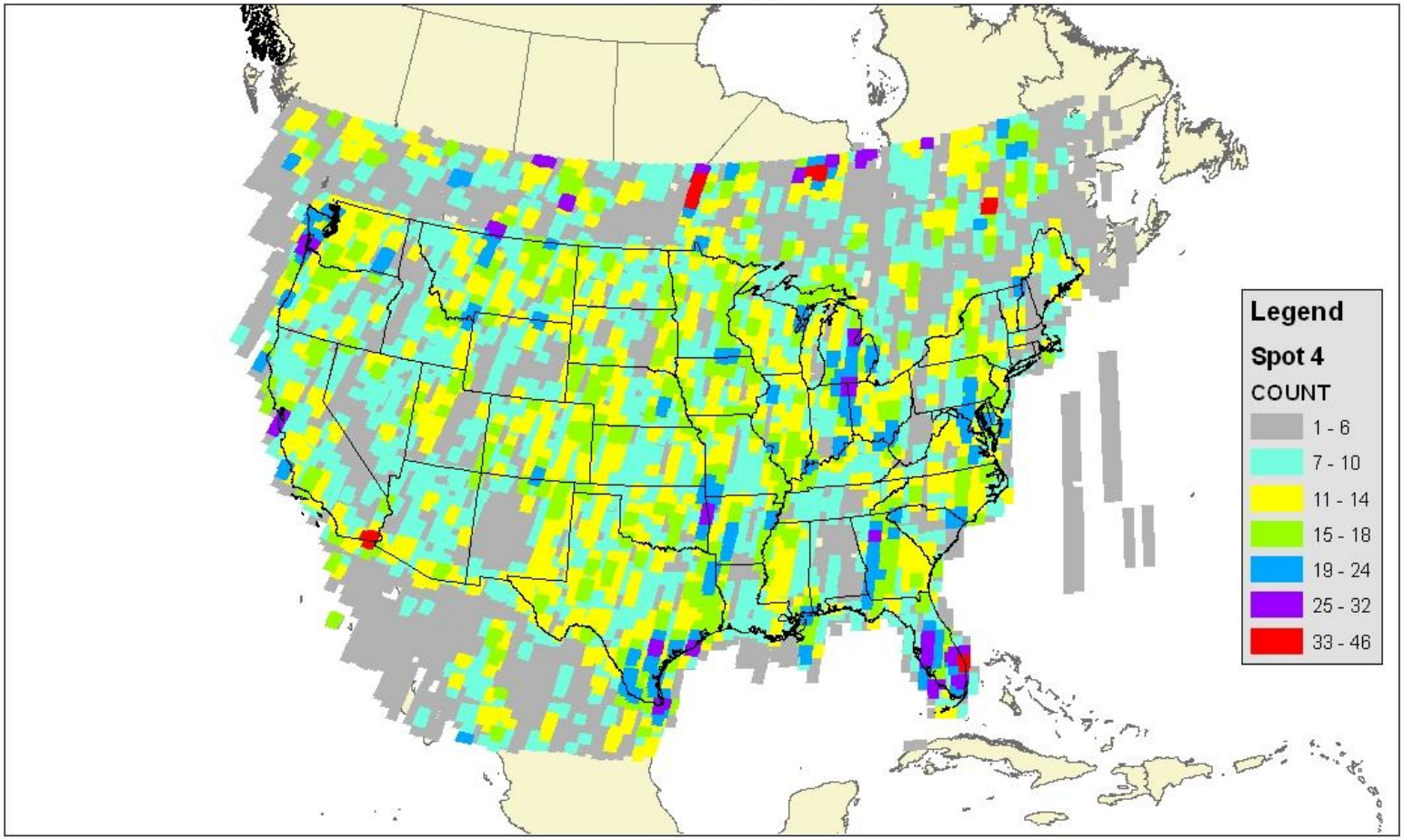
Linking U.S. Agriculture FAS to the World

Final USGS SPOT-4 and SPOT-5 Databuy Coverage
Contract Year 1



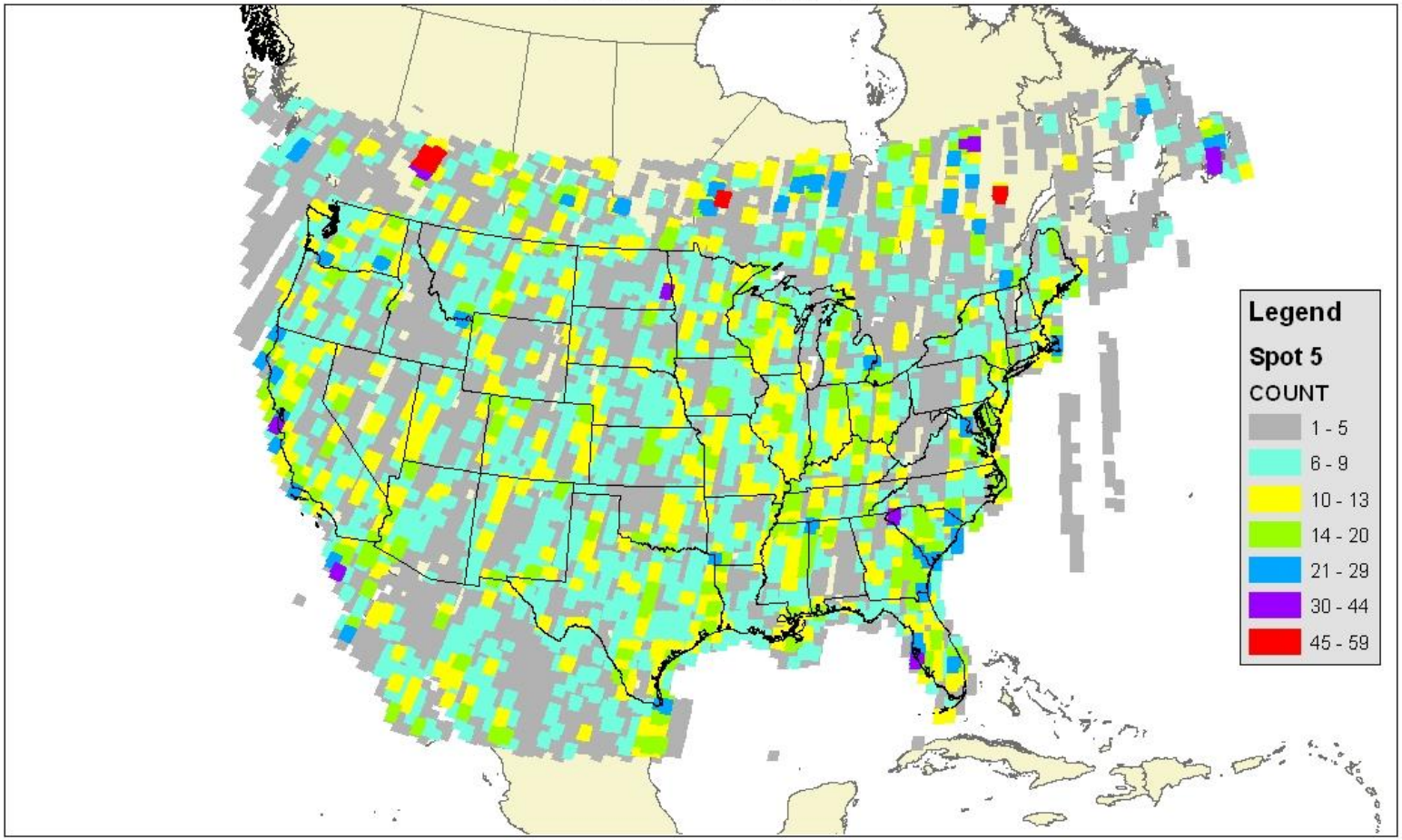
Contract Year 1

Final USGS SPOT-4 Databuy Coverage by Count
Contract Year 1



SPOT 4 Spatial Resolution = 20-meters

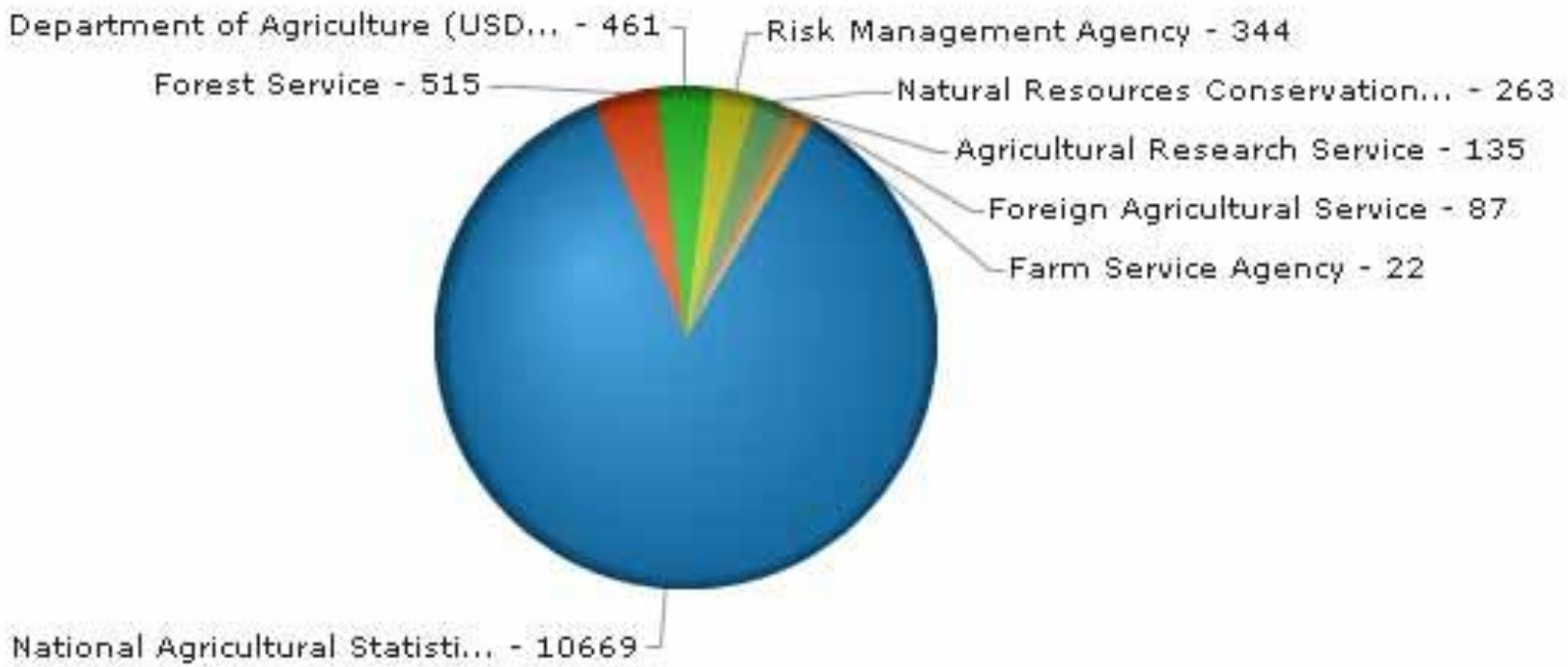
Final USGS SPOT-5 Databuy Coverage by Count
Contract Year 1



Contract Year 1

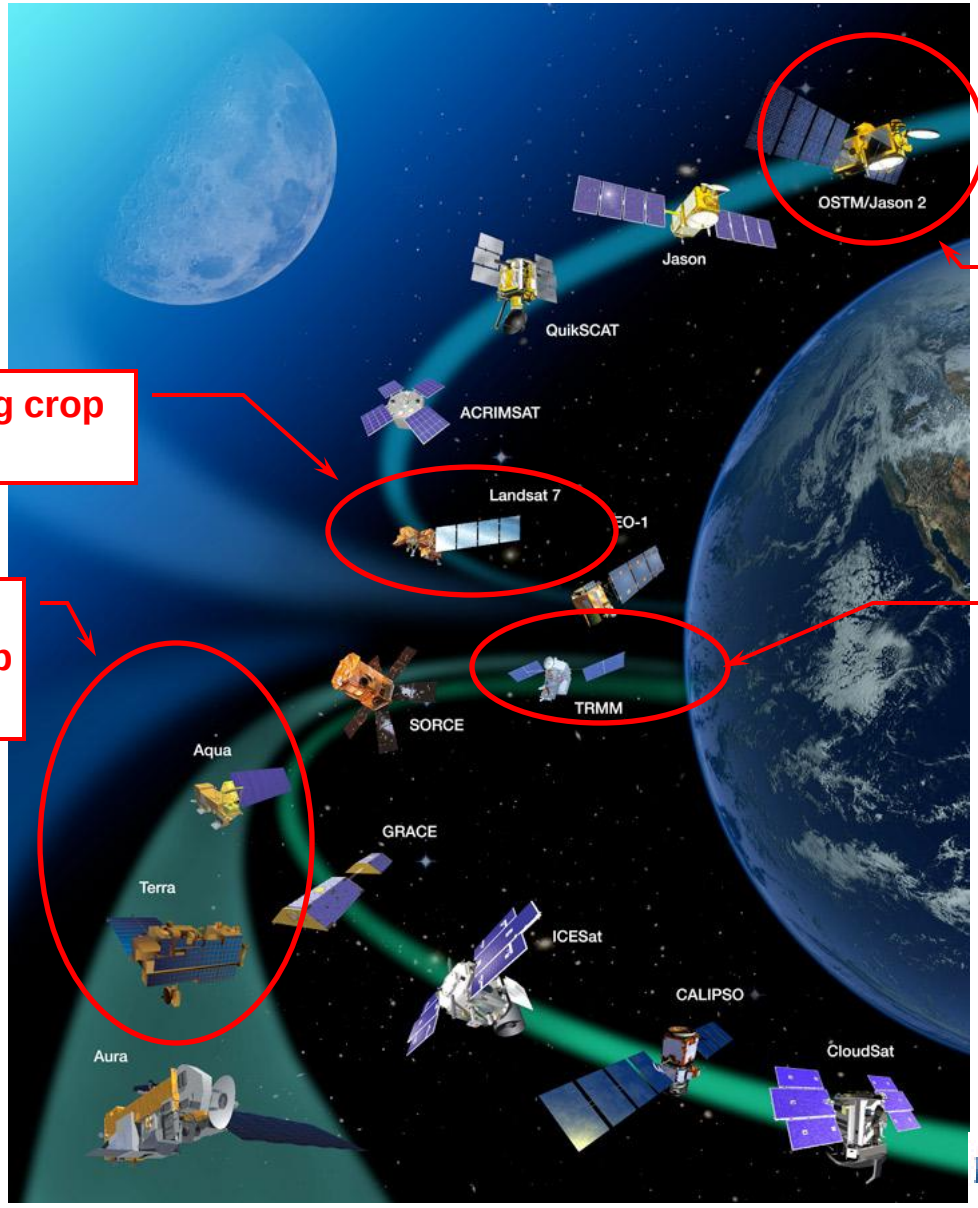
SPOT 10 Spatial Resolution = 10-meters

SPOT Imagery Downloaded by USDA Agencies during 2010



USDA Distribution

USDA Partners with NASA's Earth Observing System (EOS)



Landsat for monitoring crop area changes.

MODIS sensor for monitoring relative crop conditions and yields.

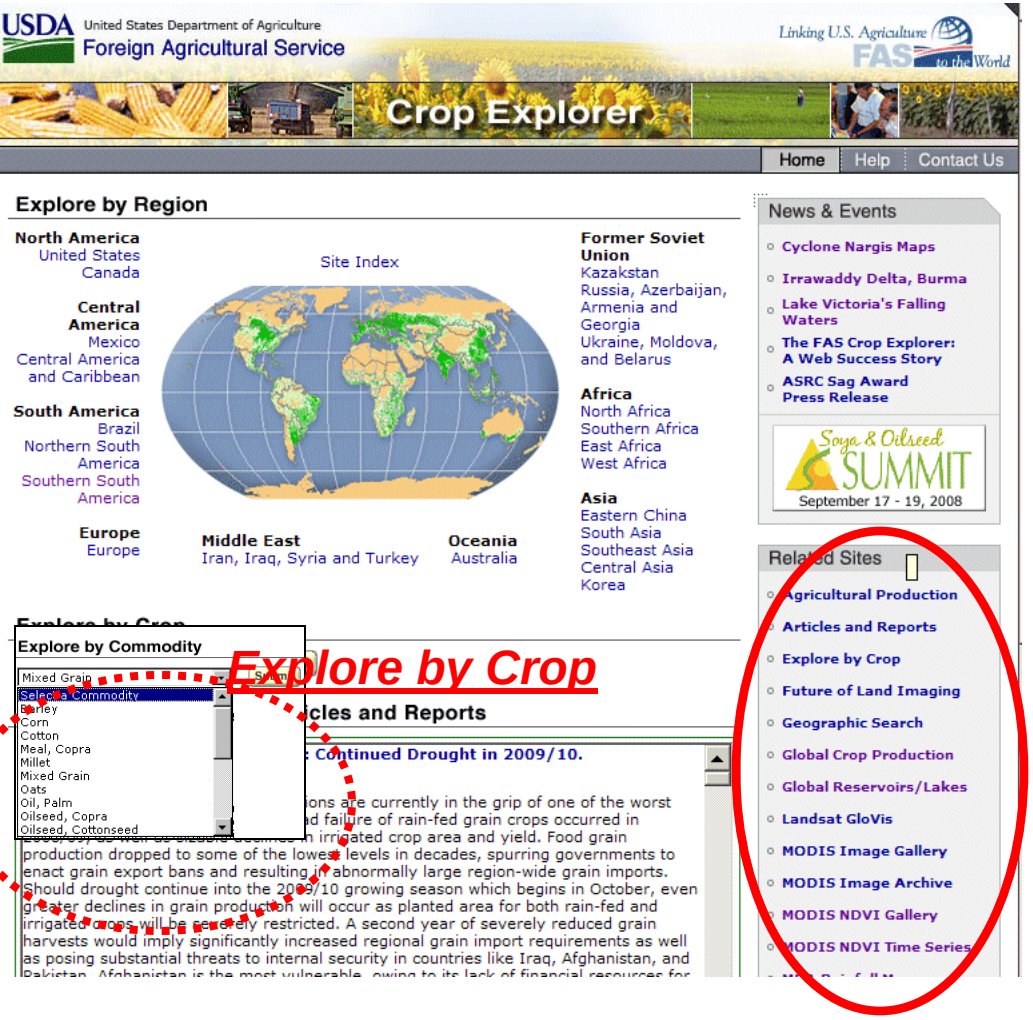
Radar satellite altimeters for monitoring reservoir and lake water levels.

TRMM for monitoring seasonal precipitation

Linking U.S. Agriculture FAS to the World

Crop Explorer

(displays numerous weather and vegetation condition data sets over major crop regions every 10-days)



Maps and time-series charts for:

Weather Data (AWFA, WMO, CMORPH, MPA, and NEXRAD)

- Dekadal (10-day) precipitation & temperatures compared to climate normals

Soil Moisture & Crop Models

- Modified Palmer two-layer soil moisture
- *Behind firewall:* Crop calendars for wheat, corn, & sorghum and corn hazard/alarm model.

Vegetation Indices (polar-orbiting satellites)

- AVHRR/GAC (8-km) (behind firewall)
- SPOT-VEG (1-km)
- MODIS (250-m)

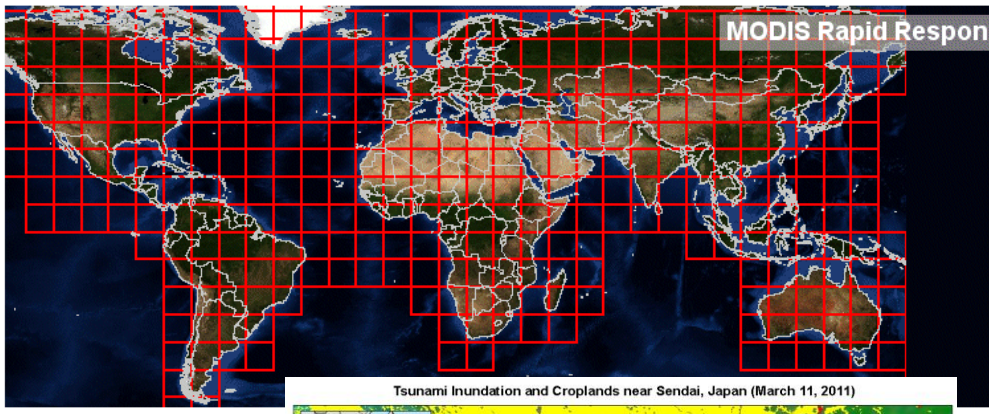
- ***Daily MODIS***
  - Aqua and Terra (250-m)
- ***Lake/Reservoir Heights***
  - TOPOX/Poseidon,Jason-1, Jason-2
  - GFO
  - ERS, ENVISAT

Crop Explorer: http://www.pecad.fas.usda.gov/cropexplorer/

Linking U.S. Agriculture FAS to the World

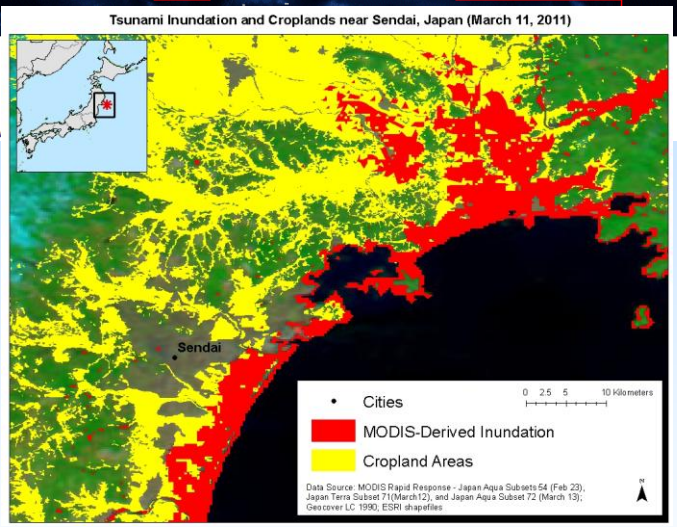
USDA-NASA Global Agriculture Monitoring (GLAM) Daily 250-m MODIS from NASA's Rapid Response

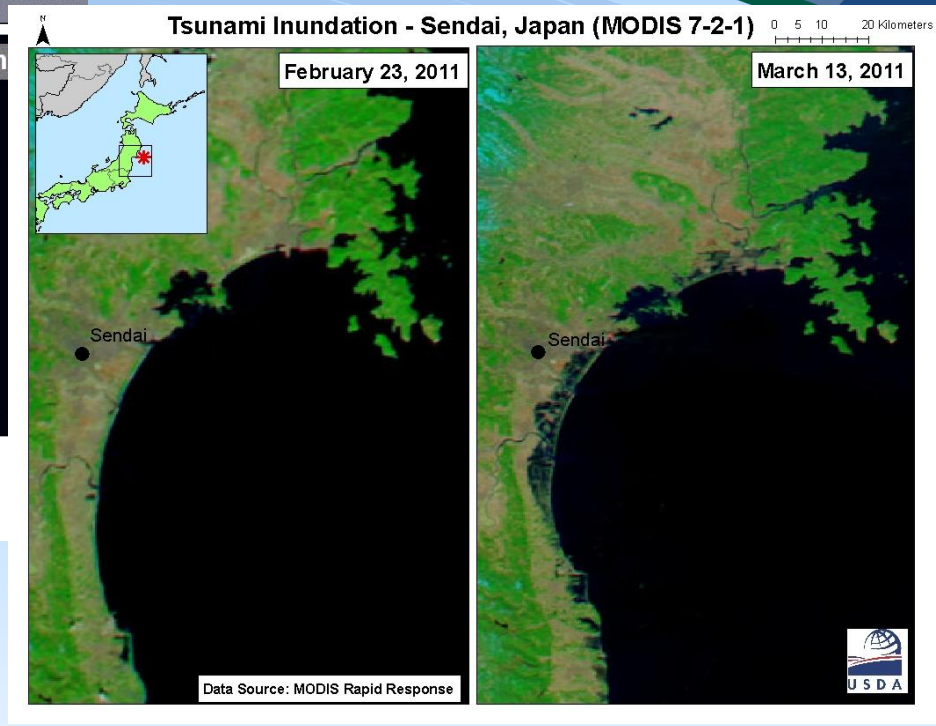
Toolbox



System Status

MODIS Imagery Import Tool for



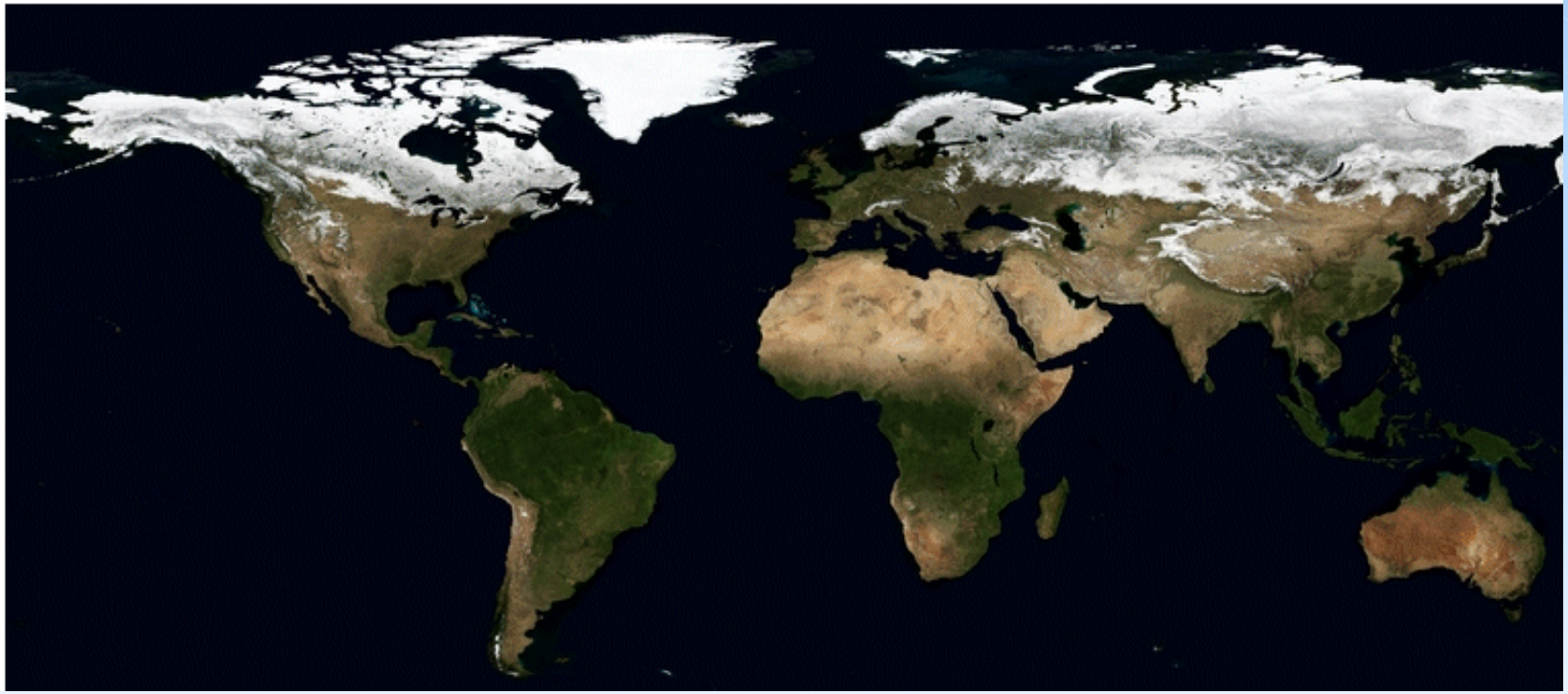


Crop Explorer/MODIS/GLAM Rapid Response:
http://www.pecad.fas.usda.gov/cropexplorer/

USDA-NASA Global Agriculture Monitoring (GLAM) 250-m NDVI-MODIS Time-Series from 2000-present

250-meter MODIS/NDVI Time Series Database from the Global Agriculture Monitoring (GLAM) Project

Please select your region of interest by clicking on the globe or selecting from the list



GLAM-MODIS NDVI Time Series for Cropland Data Drilling
http://pekko.geog.umd.edu/usda/test/

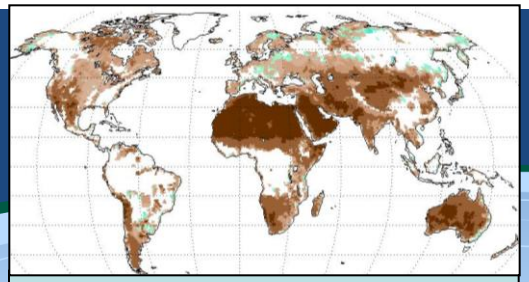
USDA

USDA NASA UNIVERSITY OF MARYLAND GLAM GLobal Agriculture Monitoring

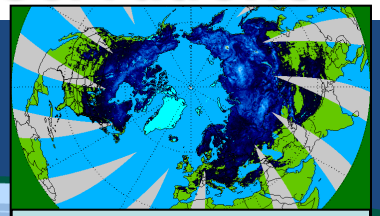
USDA/FAS/OGA

Near Future Observations

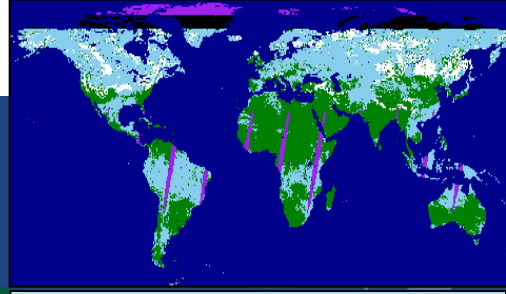
Vegetation/Carbon
(Landsat, AVHRR, MODIS, *VIIRS*, MetOp, *DESDynI, ICESat-II, HyspIRI, LIST, ASCENDS*)



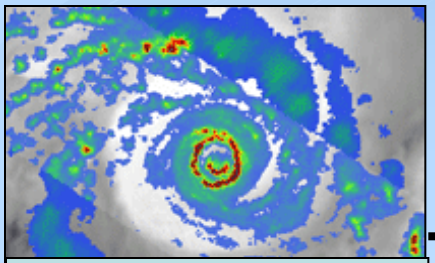
Surface soil moisture
(SMMR, TRMM, AMSR-E, *SMOS, Aquarius, SMAP*)



Snow water equivalent
(AMSR-E, SSM/I, *SCLP, GCOM-W, MIS*)



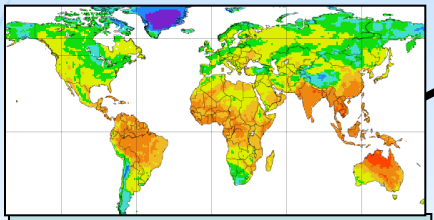
Snow cover fraction
(MODIS, *VIIRS, MIS*)



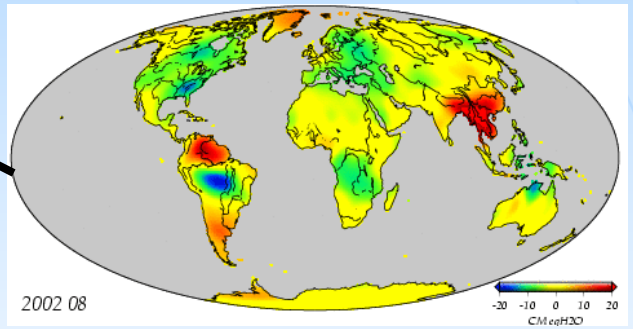
Precipitation
(TRMM, *GPM*)

Potential New Inputs for Crop Explorer or GLAM

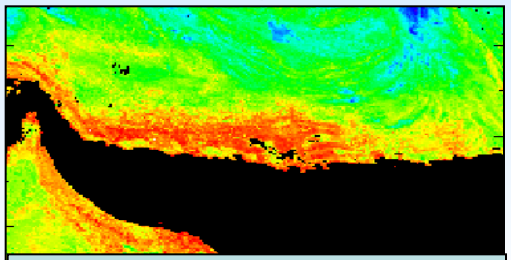
Water surface elevation
(Jason-2, *SWOT*)



Radiation
(CERES, *CLARREO*)



Terrestrial water storage
(GRACE,*GRACEII*)



Land surface temperature
(MODIS, AVHRR,GOES,…)

USDA

Modified from NASA- Peters-Lidard

Linking U.S. Agriculture FAS to the World

GEOSS: Global Earth Observation System of Systems

GROUP ON EARTH OBSERVATIONS

Home | About GEO | Meetings | News Room | Document

Home > GEOSS

What is GEOSS?: The Global Earth Observation System of Systems

- What is GEOSS?
- GEOSS Common Infrastructure
  - GEO Portal
  - Component Registry
  - Standards Registry
  - Best Practices Wiki
  - Task Force
- GEONETCast
- GEO BON
- 2009-2011 Work Plan
- Transverse Activities

Click on Societal Benefit Area icons to go to the relevant page

Source: http://www.earthobservations.org/geoss.shtml

The Agriculture Component of GEOSS

GROUP ON EARTH OBSERVATIONS

Home | About GEO | Meetings | News Room | Documents | Contact

Home > GEOSS > SBA: Agriculture > Community of Practice: Global Agricultural Monitoring

Agriculture
Community of Practice

Global Agricultural Monitoring

- About us
- Participating programs
- Meetings

Global Agricultural Monitoring System of Systems

The Group on Earth Observations (GEO) / Integrated Global Observing Strategy (IGOL) Agricultural Monitoring Community of Practice was established in July of 2007 at the second IGOL/GEO workshop convened at the headquarters of the UN Food and Agriculture Organization (FAO) in Rome. This community of practice represents twenty-five national and international organizations concerned with agricultural monitoring. Its purpose is to develop and implement a strategy for global

f GEO.

n urgent need for a comprehensive, systematic and ing system. More frequent extreme climate events such as affecting agricultural production worldwide. The risk of food he earth continues to respond to pressures such as climate pulation growth, on the land that sustains us. Understanding tion is essential to combat both short-term and long-term d for all.

ears in earth observations, involving satellite observations, d survey could revolutionize global agricultural production gement of our agricultural resources, helping to reduce hievement of the Millennium Development Goals.

e Societal Benefit Area

ural observations (satellite and in-situ) is a responsibility of Land (IGOL) program. IGOL advises the Group on Earth s for improved observation of the land surface. The Third 5, established the GEO with the mandate to lead a worldwide

Key documents

Task Sheets:

Please select a task: Go!

Other:

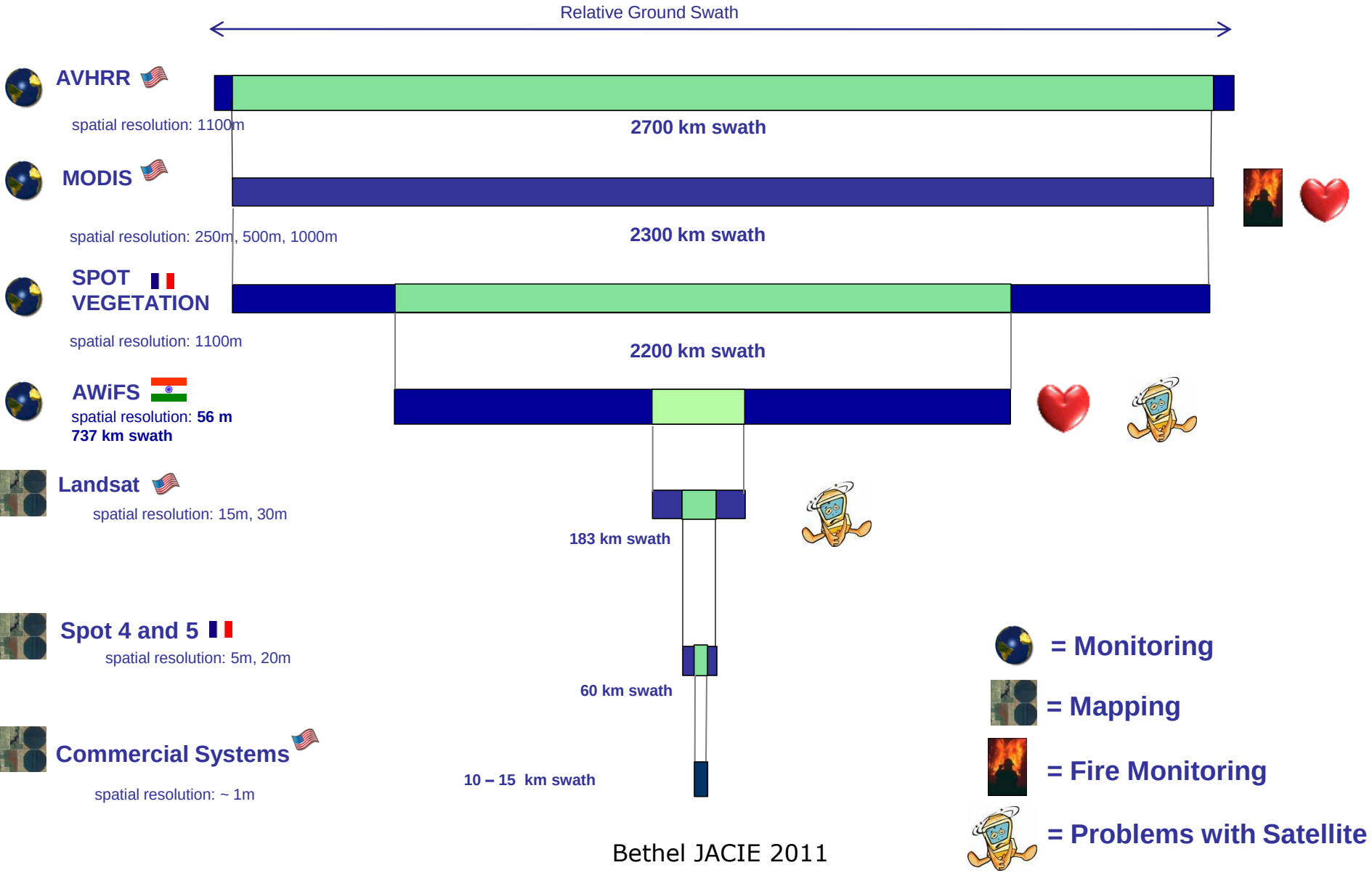
- AGM brochure
- Best practices for crop area estimation
- AG Monitoring discussion paper
- Summary Country Report
- Workshop report:

Developing a Strategy for Global Agricultural Monitoring in the framework of Group on Earth Observations (GEO)

Bulletin describes different National Crop Monitoring Systems

Source: http://www.earthobservations.org/cop_ag_gams.shtml

Current USDA Land Remote Satellite Sensing Use



Bethel JACIE 2011

Crop Monitoring Outlook for 2011

- 2011 SPOT4/5 Imagery Contract with USGS
- 2011 US Crop Season
  - RFQ for Moderate Resolution Imagery Collection for Lower-48 States from May-Oct, 2011
    - AWiFS or similar imagery with greater swath width and greater repeat coverage than Landsat
- Anticipated Launch Dates:
  - Oct. 25, 2011: NPP (NPOESS Preparatory Project)
    - VIIRS is less than MODIS but USDA/FAS plans to bring it on-line for global crop monitoring
  - April 10, 2011?- Resourcesat-2/AWiFS-

Thank you

USDA

Linking U.S. Agriculture FAS to the World